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ENVIRONMENTAL STATEMENT

REACTOR TESTING - FY 1972

Nuclear Rocket Development Station
Nevada

●

DECEMBER 1971

UNITED STATES ATOMIC ENERGY COMMISSION

NATIONAL AERONAUTICS & SPACE ADMINISTRATION

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U. S. ATOMIC ENERGY COMMISSION

NATIONAL ARRONAUTICS AND SPACE ADMINISTRATION

ENVIRONMENTAL STATEMENT FOR REACTOR TESTING DURING FY 1972 AT THE

NUCLEAR ROCKET DEVELOPMENT STATION, NEVADA

DECEMBER 1971

SUMMARY

This final environmental statement is issued jointly by the AEC and NASA in accordance with the National Environmental Policy Act and the implementing guidelines of the Council on Environmental Quality and in support of proposed administrative action to continue nuclear rocket ground development testing. It takes into account all comments received on the draft statement issued in July 1971.

A program managed by the joint AEC-NASA Space Nuclear Systems Office has been underway since 1955 to realize the potential inherent in nuclear rockets. Testing of materials, fuel elements, and design concepts is essential to progress and nineteen (19) experimental reactors and engines have been ground tested to date at the Nuclear Rocket Development Station (NRDS) in Nevada. These years of testing demonstrated the feasibility of nuclear rockets. Nuclear rocket testing is now in an essential development stage with the goal of providing a reliable, reusable, long-lived flight engine.

In this connection, a new type of reactor concept, the Nuclear Furnace, has evolved which will permit individual fuel element testing in a realistic thermal and neutronic environment at only one fortieth of the power of a full scale reactor. It is proposed to perform tests using this type of reactor at NRDS during FY 1972 and 1973.

In addition, methods of providing various facility equipment to reduce fission product release were explored and resulted in the adoption of effluent gas and liquid waste cleaning systems which are expected to be very effective and result in minimal environmental impact. However, there is expected to be an unavoidable release of small quantities of radioactivity which is not expected to exceed two to four percent of the Federal Radiation Council guidelines; possible biological effects on fish and

wildlife are not considered significant; population density or distribution will not be affected; and land utilization will be minimal and reversible and will not preclude the use of the site for other purposes after the termination of the proposed operations.

In balancing the benefits of fuel element testing with the Nuclear Furnace during FY 1972 and 1973 against the environmental costs described above, and considering the alternatives available, the U. S. Atomic Energy Commission and the National Aeronautics and Space Administration have concluded that the proposed course of action should be implemented.

1.0 INTRODUCTION AND BACKGROUND

To date vehicles used in the exploration of space have utilized rocket engines which depend on chemical combustion to provide the required propulsion. It has been known for some time that the efficiency of these rocket engines, as measured by specific impulse, is inherently limited by the physical and chemical properties of the best fuels and oxidizers known. Consequently, extending exploration of space requires more efficient vehicles to provide adequate payloads at minimum costs. It has also been recognized for some time that this higher efficiency can be provided by using nuclear energy rather than chemical combustion as the source of energy. Efficiencies of approximately twice that of the best chemical engines have been demonstrated and higher efficiencies are possible by operating at even higher temperatures.

A program managed by the joint AEC-NASA Space Nuclear Systems Office has been underway since 1955 to realize the potential inherent in nuclear rockets. Testing of materials, fuel elements, and design concepts is essential to progress and nineteen (19) experimental reactors and engines have been ground tested to date at the Nuclear Rocket Development Station (NRDS) in Nevada. These years of testing demonstrated the feasibility of nuclear rockets. Nuclear rocket testing is now in an essential development stage with the goal of providing a reliable, reusable, long-lived flight engine.

For conventional chemical rocket engines, the development process has involved the building of large numbers of engines and full scale testing for hundreds of hours. For reasons of economics and difficult design requirements, this pattern is not optimum for nuclear rockets and many alternatives have been explored. As a result, a different approach to engine development has evolved. It places heavy emphasis on in-depth engineering in the design phase to discover and eliminate as many problems as possible before fabrication begins. Thorough testing at the materials, parts and components level is emphasized prior to full scale reactor/engine tests (at about 1575 Megawatts-thermal). For example, the majority of fuel element development testing is accomplished using electrical heating rigs. While this does not completely simulate the thermal and neutron environment of the reactor, very valuable information is gained and there is no adverse environmental impact. Small scale (one fourth power) reactors such as the "Pewee" have also been used to provide realistic inter element test conditions at less expense. More recently, the Nuclear Furnace concept has evolved which will permit individual fuel element testing in a realistic thermal and neutronic environment at only one fortieth of full power to supplement electrical testing. A reasonable number of full scale reactor and engine tests are, of course, required to assure satisfactory solutions to integration and control problems. This step-wise approach to engine development is believed to be most likely to result in success and to be the most economical. It also is believed to result in minimal environmental impact.

1.1 Test History

Beginning with the first test in 1959, nineteen (19) experimental reactors and engines have been tested at the NRDS. Peak power levels achieved during these tests ranged from 70 megawatts-thermal (MWt) to 4100 MWt while test durations varied from a few seconds to about one hour. The longest single test was conducted in 1967 when a power level of 1100 MWt was sustained for one hour. The highest power operation of about 4100 MWt was attained in 1968 for a duration of about 12 minutes.

All of the nuclear rocket concepts explored to date depend on fission of Uranium (U-235) in the fuel elements of the reactor. To remove the energy deposited by fission, hydrogen gas is pumped through small axial passages in the fuel elements where it is heated to temperatures approaching 4000°F. After collection in a plenum, it is then expanded through a convergent-divergent nozzle and exhausted to the atmosphere at very high velocities to provide thrust. After leaving the nozzle, the hydrogen gas is ignited and burned in air forming water vapor.

The fission process which provides the heat necessary for operation of nuclear rockets also generates radioactive fission products in direct proportion to the power level and operating time. Since nuclear rocket fuel elements must operate at very high temperature, it is impossible to fully contain all the fission products even though the flow passages are coated with a high temperature resistant ceramic material. Consequently, a small percentage of the fission products generated during power operations become entrained in the hydrogen gas as it flows through the reactor and remain with it as it is exhausted into the atmosphere and burned. Due to its high exhaust velocity and the additional heat generated as the hydrogen is burned, the plume rises to several thousand feet.

As the effluent moves downwind, it expands rapidly due to turbulent diffusion and thus continuously reduces the concentration of radioactive fission products. Moreover, most fission products decay rapidly with time so that concentrations are low by the time the effluent reaches inhabited areas. Direct and indirect exposure to the passing effluent, however, is the primary environmental effect of nuclear rocket testing at the NRDS.

The effects of nuclear rocket testing on the environment on-site are measured and reported by Pan American World Airways, the NRDS support services contractor, and off-site by the Western Environmental Research Laboratory (formerly the Southwestern Radiological Health Laboratory) of the Environmental Protection Agency [1a thru g]. A recent report[2] records the experience over the total period of nuclear rocket testing at NRDS in the form of a summary table below. This table is based on actual physical measurements made in the field following reactor testing and gives sum of the highest values measured over the year within the 45° sector which had the highest sum of all the eight sectors surrounding the test area. Measured air, water and milk concentrations are converted and expressed in terms of hypothetical dose, that is, the dose which would have been received from NRDS operations had a person been out of doors throughout the year at the point of maximum concentration off-site within the sector. Calculated thyroid doses assume both inhalation and ingestion by an individual of the most sensitive age, i.e., children one year old. These hypothetical doses are compared with Radiation Protection Standards[3,4] in the following table.

COMPARISON OF MAXIMUM HYPOTHETICAL WHOLE-BODY EXPOSURES AND HYPOTHETICAL THYROID DOSES WITH RADIATION PROTECTION STANDARDS

Type of Exposure/ Dose	Radiation Protection Standard 1/	Maximum Whole-Body Exposure and Thyroid Doses (rem)						
		'59-63	'64	'65	'66	'67	'68	'69 3/
Whole Body Exposure	.500 rem/yr	ND 2/	.001	.006	.020	.002	.001	.001
Thyroid Dose	1.500 rem/yr	.003	.024	.072	.036	.018	.013	.002

For any given year, the hypothetical whole-body exposures and thyroid doses were below 4% and 5%, respectively, of the Radiation Protection Standards for individuals in non-controlled areas. It should be noted that the Western Environmental Research Laboratory of the EPA gives priority to sampling locations where people actually

1/ Standards are for individuals, AEC Manual Chapter 0524 and Federal Radiation Council Guidelines

2/ ND - Not detectable

3/ No tests were conducted in CY 1970 nor are tests planned in CY 1971.

reside (farms, ranches, communities). Concentrations may have been somewhat higher or lower at other uninhabited off-site locations. In most cases, the hypothetical doses reported as possible were not actually received due to protection afforded by buildings, diversion or interruption of the milk chain, and the improbability that any individual was actually located in every case along the line of maximum concentration within the sector.

2.0 PROPOSED ACTION FY 1972

2.1 Nuclear Furnace Description

A new type of reactor called the Nuclear Furnace is to be tested at the NRDS during FY 1972. It differs in several respects from reactors tested in the past: the power level is considerably lower, it does not exhaust directly into the atmosphere, and except for the core of fuel elements, it is reusable. The Nuclear Furance, depicted schematically in Figure 1, is designed for the purpose of testing advanced nuclear rocket fuel elements. Where a core of approximately fifty such fuel elements is inserted into the configuration, it is capable of sustaining a steady state fission reaction within the elements thus closely simulating the thermal and neutronic environment expected in a nuclear rocket engine. Each fuel element is surrounded by, but physically separated from, a flowing water system which moderates the neutrons formed by the nuclear fission process and also acts as a coolant of subsystem materials. The assembly of fuel elements and the water channels are further surrounded by a beryllium neutron reflector containing control drums, and by a pressure vessel. The overall assembly is cylindrical in shape with a diameter of three feet and a length of approximately seven feet.

Hydrogen is pumped into the upper plenum of the assembly and flows down through the fuel element channels during which time it is heated to temperatures of about $4000^{\circ}F$. The hot hydrogen gas exits from the fuel elements and enters into a lower plenum where it mixes with and vaporizes the coolant water. This combination of hot hydrogen gas and steam exits from the plenum, passes through a filter, and enters a facility system which condenses the steam and separates the condensed water from the hydrogen gas.

Fuel elements to be tested in the Nuclear Furnace during FY 72 will be of two types known as "graphite" and "composite". The two types are similar in many respects. Physical shape and dimensions are identical; both utilize graphite as the matrix or basic structural material. Axial hydrogen flow passages running the full length of both types are coated with a high temperature resistant ceramic which minimizes chemical reaction between the hydrogen gas and the graphite matrix. Although uranium is used as the fuel (fissionable material) in both types, it is in a different form in each.

In the graphite elements which have been used for the last several reactor tests, the fuel is in the form of uranium di-carbide microspheres, distributed within the graphite matrix. In composite elements, much smaller, uncoated particles of uranium-zirconium carbide solid state solution are dispersed within the graphite matrix.

In both cases, some of the fission products diffuse out of the elements and into the hydrogen gas as it passes through the flow passages -- more so with composites than with graphite elements. On the other hand, there is much less corrosion of the composites. A small amount of methane is also generated from the interaction of hydrogen with the carbon in the fuel elements.

Any discrete particles which may result from fuel element corrosion will be trapped in the exhaust gas cleaning system. Except for noble gases, the majority of fission products diffusing from the core are expected to become entrapped in the water phase as the steam condenses. The gaseous effluent then passes through an activated charcoal bed which is expected to remove any iodine remaining and may also hold up a substantial fraction (up to 90%) of the noble gases. The efficiency of the charcoal bed for noble gases cannot be stated with confidence at this time, however, because of the presence of the methane which may limit the absorption capacity of the bed. Any fission products not trapped in water or charcoal and retained in the hydrogen gas will be released through a flare stack to the atmosphere. The liquid water stream will be piped to a holding tank. Following the test, the contaminated water will be passed through an ion exchange system to remove the fission products before it is routed to the facility tile field. Both avenues of release and their impact on the environment are treated in Section 6.

Following each test series, the Nuclear Furnace is returned to a facility where the core containing the fuel elements is removed and replaced with a new core for follow-on tests. The pressure vessel, beryllium reflector, control assembly, and test cart are reused in subsequent tests.

2.2 Test Plan for FY 1972

During FY 72 possibly two Nuclear Furnace cores, NF-1 & NF-2 will each be tested at Test Cell C at a nominal power of 40 MWt. Testing will consist of a number of 10 minute operations at power with a short interval of a minute or so at very low power between each 10 minute power operation. Not more than 5 or 6 ten minute tests will be made in any one day and a period of a week or two will separate each operating day. Total accumulated duration at 40 MWt will not exceed two hours for NF-1 nor 10 hours for NF-2. NF-1 testing is planned in the spring of 1972. Operation of NF-2 will begin late in 1972 and continue in 1973.

Reactor parameters such as fuel element temperature and control drum position indicate reactor conditions affecting fission product release and will be closely monitored and controlled as usual. Also, effluent samples taken during the first set of NF-1 tests will be carefully evaluated to determine the fission product removal efficiency of the exhaust gas cleaning system. On the basis of this information, the remaining tests will be planned and controlled so as to assure that human exposure and environmental impact is well below Federal Guidelines.[3, 4].

3.0 ENVIRONMENTAL SETTING

3.1 Location and Topography

The NRDS is a part of a large government controlled complex which also includes the Nevada Test Site, where the Nation's underground tests are conducted, and the Nellis Air Force Base Gunnery Range. Access to this whole complex is restricted.

The NRDS itself is located in the southwestern Jackass Flats region of the Nevada Test Site (NTS), in Nye County, Nevada, about 82 air miles northwest of Las Vegas. Figure 2 shows the relative location of the complex within Nevada and to surrounding states while Figure 3 shows the location of the NRDS with respect to other areas of the NTS. The area of NRDS is approximately 93,000 acres. Surrounding the NRDS are mountain ranges which reach altitudes of 5,000 to 7,500 feet above mean sea level (MSL). Jackass Flats, on which NRDS is located, is a valley at an altitude of approximately 3,500 feet MSL which slopes slightly downward fron the northeast to the southwest. It is bounded by Calico Hills and Shoshone Mountains on the north; by Skull Mountain, Kiwi Mesa and the Spector Range on the east and south, respectively, and by the Yucca Mountains on the west and northwest. The Yucca Mountains are separated from the NRDS area by Fortymile Canyon and Fortymile Wash. The Canyon and Wash comprise a deep dry river bed.

3.2 Geology

The surface rocks at the NRDS consist of varied sedimentary and volcanic rocks and alluvial deposits. The alluvial character of the soil and underlying deposits in the area of the NRDS consists of sand, gravel, boulders, and silt, with a depth estimated to be between 50 to 300 feet. Material below 300 feet is volcanic and sedimentary and consists mostly of metamorphosed tuff. It extends, in places, to a depth of up to 5,000 feet. The bedrock, which is predominantly limestone and dolomite, extends to unknown depths in this area. The compacted alluvial soil at NRDS exhibits excellent filtering properties. The underlying volcanic rock consists primarily of tuff. Tuff contains a high percentage of zeolite which has excellent ion exchange properties.

3.3 Climatology

3.3.1 General

The meteorological program of the U. S. Department of Commerce, Air Resources Laboratory, Las Vegas, Nevada, as it relates to NRDS testing, was started in 1956. Continuously since that time considerable effort has been made to improve the reliability of prediction and measurement of meteorological parameters which influence safe conduct of tests. A number of meteorological stations are located throughout the area to measure various meteorological parameters including wind direction and speed, temperature, relative humidity, and precipitation. Upper-air soundings are taken on a routine basis at Yucca Flats, and as required at NRDS. Pilot balloon observations are made at selected stations on the Nevada Test Site and environs at times and locations prescribed prior to a test. The results of these observations provide the vertical distribution of wind speed and direction throughout the atmospheric transport layer. With as many as six stations taking observations simultaneously the spatial variation of wind velocity over the Test Site area is also known. This information is used to assist meteorologists in predicting the effluent cloud trajectory. Tetroons (tetrahedron shaped constant pressure-altitude balloons) are released at run time to fly at the altitude of predicted maximum activity. The radar observed tetroon trajectory gives an excellent real-time indication of the effluent cloud trajectory.

A climatological summary has been given in ESSA Technical Memorandum ERLTM-ARL7, "Climatological Data -- Nevada Test Site and Nuclear Rocket Development Station", dated August 1968.

A brief description of important meteorological parameters follows.

3.3.2 Temperature

During a ten-year period of record, the extremes of temperature have varied from a low of 7 degrees Fahrenheit (F°) in January to a maximum of 110°F in both June and July. During winter months, the average maximum temperature is approximately 57°F with an average minimum of approximately 35°F and an average diurnal range of 22°F. The summer data indicate an average maximum of about 95°F, an average minimum of about 75°F, and an average diurnal range of 28°F. Strong low-level temperature inversion conditions typical of the southwest desert are not as pronounced at NRDS because of the effectiveness of the nighttime drainage wind in keeping the lower atmospheric layer mixed. These shallow inversions generally begin to form near sunset and intensify during the night until shortly after sunrise when they begin to be destroyed by surface heating.

3.3.3 Wind

During the summer months there is a very pronounced diurnal reversal in wind direction, southerly winds (upslope) predominating during daylight hours and northerly winds (downslope) predominating at night with the reversal occurring a few hours after sunrise and again shortly after sunset. During the winter months, northerly winds are predominant at all hours with some increase in the frequency of southerly winds indicated during midafternoon. The average windspeeds are lowest near the time of wind direction reversals, which are more predominant during summer months. The diurnal variation in wind speed is less pronounced during winter months which has an average speed of about 10 miles per hour. The average wind speed by months shows a maximum of 12 miles per hour in March and April with a maximum of 9 miles per hour from November through January.

3.3.4 Precipitation

The average annual precipitation at NRDS is approximately four inches. Precipitation amounts are a minimum during May and June and reach a maximum from December through February. There is a secondary maximum in July and August associated with summer thunderstorms. There is an average of about 15 thunderstorm days per year with a large variation in precipitation amounts with each storm and at various locations. Localized flooding of dry streambeds frequently occurs with summertime thunderstorms.

3.3.5 Relative Humidity

The relative humidity over southwest desert regions is usually quite low and NRDS is no exception with an average minimum of 14% in June (onset of the hot season) and an average maximum of 70% in March. On a daily basis, a maximum is reached just before sunrise at time of minimum temperature and the minimum occurs late in the afternoon near the time of maximum temperature. Large deviations in relative humidity occur with summer thunderstorms and with large scale storms from late fall through spring.

3.4 Seismology

Nevada is moderately active seismically compared to the rest of the United States but less active than some parts of California. The closest large California earthquake was 100 miles west of the NRDS. The recent San Fernando earthquake which occurred 200 miles to the southwest on February 9, 1971, at 6:00 a.m. PST registered 6.6 on the Richter scale. A peak horizontal acceleration of 1.1 g was recorded approximately two miles from the epicenter. The approximate horizontal ground motion acceleration at NRDS was .003 g or approximately one-tenth of a Zone 1 earthquake motion (.025 g acceleration). According to the U. S. Coast and Geodetic Survey the only recorded earthquake in the near vicinity of the NRDS occurred in 1959 approximately 5 miles to the east and registered 4.0 on the Richter scale.

The Uniform Building Code (1970) Seismic Risk Map of the United States places NRDS on the boundary between Zone 1 and Zone 2. However, the present criteria for design of all NRDS structures is Zone 3 (approximately magnitude 7 on the Richter scale). All existing test facility structures have been strengthened to withstand a Zone 3 magnitude earthquake. All earthquake engineering has been performed by John A. Blume and Associates.

3.5 Hydrology

3.5.1 Surface Water

There are no natural surface water basins on or in the immediate vicinity of the NRDS except during those infrequent periods when a rainstorm occurs. During these infrequent periods, the rain water will collect and be channeled along the many water courses at the NRDS. The major water course aside from Fortymile Canyon and Wash, is the Topapah Wash which runs southwesterly from Jackass Divide in the northeast corner to the middle of the south side of the site.

3.5.2 Subsurface Water

At the western edge of the NRDS approximately seven miles from the nearest facility are aquifers tapped by wells at a depth of about 1000 feet. Water is pumped from these wells for NRDS needs. Other aquifers are located deep underground throughout the NRDS at depths of approximately 1000 feet below the ground surface. A number of these aquifers are unsuited for domestic or operational use because of the high content of naturally occurring inorganics, particularly fluorine which has its origin in the cryolite deposits prevalent in the area.

3.6 Access to NRDS

3.6.1 Air Access

As part of the Nevada Test Site complex, the air lanes over NRDS are closed to commercial and private air traffic. There are two landing strips operated by the government - one on Yucca Flats which is restricted and located within the NTS about twenty-three miles northeast of NRDS, and an unrestricted strip at Camp Desert Rock just outside the NTS and about twenty miles southeast of the NRDS. The nearest public airstrips for small aircraft are located at Lathrop Wells and Beatty, Nevada.

3.6.2 Road Access

Primary access to the NRDS is by way of Route 95 which connects Las Vegas with Reno and runs about 15 miles south of test locations at the NRDS. Two access roads branch off from this highway to the NRDS.

3.6.3 Railroad Access

There is no railroad access to the site. The nearest public railroad is the Union Pacific, which travels in a north-south direction through Las Vegas passing about 90 miles southeast of NRDS.

3.7 Bioenvironment

Vegetation of the NRDS is limited by type of soil and meager rainfall to desert shrubs, principally sagebrush and some cacti. There are no trees or grasslands on the Station.

The wildlife in the area consists mainly of small mammals, desert-inhabiting birds and reptiles. Aquatic life is minimal. The mammals include such forms as kangaroo rats, several species of mice and the desert hare. Mule deer and antelope sometimes frequent mountainous regions to the north. A few wild mustangs, burros and sheep are occasionally seen in these mountain regions. In addition to chukars, raptors and other indigenous and introduced species of birds, some migrant species pass through the area. The reptiles consist mainly of lizards, the desert tortoise, an endangered species, and a few snakes. There are no domestic animals on the NRDS.

Fish within 50 miles of the Station include the Devil's Hole Pupfish and Pahrump killifish, both endangered species.

The Atomic Energy Commission conducts extensive bioenvironmental monitoring and studies at the adjacent Nevada Test Site and sponsors many others with universities and other research organizations. The Space Nuclear Systems Office maintains contact with this program and participates in its planning activities but does not itself conduct such research. A summary of this work is given in Annex A of the Environmental Statement for Underground Nuclear Test Programs, Fiscal Year 1972, Nevada Test Site (tests of 1 megaton or less). For convenience, this Annex is included in its entirety as Annex A to this statement.

3.8 Population

The nearest public center of population is Lathrop Wells, with a population of about 40 people, located approximately 16 miles south of the NRDS test locations. The Amargosa Farm area ranging from 19 to 26 miles southwest of Test Cell C at the NRDS has a population of about 195. Other surrounding communities include:

Community	Population	Distance & Direction from Test Cell C
Beatty	800	26 miles west
Indian Springs	2000	40 miles southeast
Ash Meadows	60	32 miles south
Pahrump	1350	40 miles southeast
Death Valley Junction	24	38 miles southwest

The population to the north is very sparse to a distance of about 100 miles.

Within the Government complex, there are about 500 residents at Camp Mercury on the NTS and about 200 operating personnel on the NRDS.

The Western Environmental Research Laboratory of the Environmental Protection Agency maintains an accurate census of human (and dairy cattle) population in Nevada and adjoining states. This information is available to the Space Nuclear Systems Office (SNSO) in current form for test planning and is graphically displayed for use by the Safety Advisory Panel. (See Sec. 6.7.2).

During the past decade of testing at the NRDS there has been no significant change in the population census or distribution in areas bordering the NRDS and Nevada Test Site.

3.9 Surrounding Land Use

The Nevada Test Site (NTS) bounds the NRDS to the east and the north and is used for the underground testing of nuclear weapon devices.

To the north and east of the Nevada Test Site is the Nellis Air Force Range, a large restricted area under the jurisdiction of the U. S. Air Force, which is used by Nellis Air Force Base for bombing and gunnery practice.

The land usage outside this large government complex consists of small ranches and farms. Recreation areas include Lee and Kyle Canyons located 50 miles southeast of NRDS and Death Valley, California, located 45 miles to the southwest.

The closest dairy herds of any size are approximately 75 miles to the northeast. Several ranchers maintain family cows which are included in the census maintained by the Western Environmental Research Laboratory. Agriculture in this particular location is devoted primarily to hay, alfalfa, and some wheat.

The Pahrump Valley south of the NRDS is mainly devoted to raising alfalfa and cotton. To the immediate west there is minimal land usage. The closest farming area is the Amargosa Valley, located south of Highway 95 where there is some production of foodstuffs.

3.10 Archeology

Worman* has reviewed the archeological investigations of the NTS area, only a few of which predate AEC occupation of the site. A study of Worman's paper suggests that a good deal of private artifact collecting has taken place on the site, not all of it confined to surface finds. Much of the material presented by Worman is derived from such collections, which are rather well documented. Formal salvage archeological work, except for that done by Worman, appears to have been minimal.

The NTS operating procedures set responsibilities and procedures for assuring protection of any antiquities or historic sites on NTS as required by the Antiquities Act of 1906** and the Historic Sites Act***. These procedures are being applied to avoid loss of archeological and historical values at NTS.

4.0 FACILITIES

The Nuclear Rocket Test Program is conducted within a complex of facilities which are widely separated from each other within an operational area of about 13,000 acres out of the 93,000 acres comprising the NRDS. Figure 4 shows the general layout of the facilities on NRDS which occupy approximately 300 acres.

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* Worman, F.C.V., "Archeological Investigations at the U. S. Atomic Energy Commission's Nevada Test Site and Nuclear Rocket Development Station," Los Alamos Scientific Laboratory Report LA-4125, 1969.

** Antiquities Act of 1906 (16 USC 431-433)

*** Historic Sites, Buildings and Antiquities Act of 1935 (16 USC 461-467)

The necessary roads and an on-site railroad system linking the major test and operational facilities for the movement of test articles were initially constructed in 1959 and subsequent additions made in the following years as new facilities were constructed. The road system now involves about 25 miles and the rail system approximately 15 miles. There are no plans in FY 1972 to construct new test facilities or roads or add to the railroad system; however, there will be minor modifications to Test Cell C.

4.1 Engine Maintenance, Assembly and Disassembly Building (E-MAD)

Final reactor assembly operations are performed at the E-MAD Building in preparation for transfer to the test cell. Following a test, the reactor is returned to E-MAD for disassembly, inspection, and analysis of parts and components.

All disassembly operations are performed by personnel using remote manipulator systems which penetrate high density concrete walls up to six feet in thickness. The discharge air from the hot disassembly bay passes through a system of high efficiency filters and is continuously monitored.

4.2 Test Cell C

The Nuclear Furnace is being tested at Test Cell C which consists of a concrete pad on which the assembly is located during test, fluid storage and transfer facilities, instrumentation and control systems, exhaust gas and liquid waste cleaning systems, and a flare stack. As described in paragraph 1.2, the hot hydrogen gas and steam mixture containing fission products exhausts from the Nuclear Furnace through a filter and into a gas cleaning system. Heat exchangers in this system cool the mixture to near room temperature so that the steam is condensed to liquid water. On the basis of previous experiments, the majority of fission products other than noble gases are expected to be entrained in the water phase. The gaseous effluent then passes through an activated charcoal bed which is expected to remove most of the iodine remaining and a substantial portion of the noble gases, xenon and krypton. The liquid waste water is piped directly to a holding tank. Following the test, the water is drained through an ion exchanger, which will remove and retain the fission products. After several uses, the ion exchanger will be removed and transferred to the Radioactive Material Storage Facility for storage.

4.3 Other Facilities

Other test and assembly/disassembly facilities shown on Figure 4 will not be used for reactor testing during FY 1972.

4.4 Radioactive Material Storage Facility (RMSF)

The RMSF is located directly north of the E-MAD. The area is completely fenced and access is restricted. Fuel elements and radioactive parts resulting from the disassembly operations are stored in this area. Small amounts of solid and liquid radioactive wastes packaged in suitable containers are also stored in this area.

Pending radioactive decay and reprocessing, fuel elements are stored in containers on flatbed railroad cars which are covered to provide weather protection. Since very little heat is generated within them, active cooling is not required.

4.5 Support Facilities

In the immediate vicinity of the Control Point and further to the south are a number of support facilities consisting of a medical facility, warehouses, shops and the administration building.

4.6 Electrical and Water Systems

4.6.1 Electric Power

The NRDS is supplied with electrical power originating from two independent commercial sources. Both sources feed into a single substation located near the entrance to NRDS from which an electrical network fans out to the various site facilities. In addition to commercial power, each major test facility is capable of being supplied electrical power by diesel generator systems. The latter, however, are used only during commercial power failures and during test periods when they act in parallel with the commercial supply in order to provide an auxiliary source. The commercial electrical supply is transmitted to the NRDS by overhead lines as is customary in most non-urban areas and desert regions.

4.6.2 Water Supply

Water for station needs is drawn from a large aquifer located approximately seven miles from the nearest NRDS facility at a depth of about 1000 feet. By a systems of wells and pumps, the potable water is piped to a number of elevated water tanks throughout the NRDS.

4.7 Solid Radioactive Waste Disposal Facility

The radioactive waste burial site in use on the NRDS is located near the R-MAD building. The area is completely fenced and access is restricted. Decontamination materials, and other contaminated material containing a total of less than 500 curies of mixed fission products at time of burial have been disposed of in this area. Current total inventory is estimated at less than 20 curies. Burial is made in trenches approximately 200 to 450 feet in length, 10 feet in width and 10 feet in depth. The radioactive materials are covered with at least six feet of soil.

5.0 ENVIRONMENTAL IMPACT - UNAVOIDABLE EFFECTS

5.1 Construction

Construction activities are conducted in compliance with the AEC and NASA design criteria, which stipulate, in part "During construction of facilities, provisions will be made to minimize soil erosion and water and air pollution. Site studies shall include information required to plan and design the measures needed to provide an acceptable degree of pollution and erosion control for the site". The criteria also specify measures to be considered in the preparation of plans and specifications to effect minimal disturbance to the environment, and provide for disposal of construction refuse in such a manner as to minimize environmental pollution. In any event, environmental pollution during construction is of a temporary nature and localized in extent.

Road construction is required to conform to local State Highway Department standards and practices. Surface changes resulting from road construction are minimal since road design generally follows the natural contour of the ground with cuts and embankments held to an absolute minimum.

The principal disturbances to the surface terrain at the NRDS have resulted from construction operations. Recovery is quite slow in disturbed areas, and is prevented in those areas where facilities and roads are established and likely to remain. However, because of the relatively small area occupied by these developments and the character and isolation of the site, construction has had no significant adverse environmental impact.

Materials of construction on or near the reactor and engine test stands are selected so that any induced activity is relatively small. Therefore, the facilities could be dismantled and removed. Consequently, there is no irreversible, long term commitment of the land.

5.2 NRDS Land Use

The land currently utilized is of no significant agricultural or recreational value. Nevertheless, land use at NRDS takes into consideration the obligation to conserve real estate, consistent with the requirement for safe operation of facilities and test equipment. In general, location of facilities takes advantage of topographical features with minimum impact on the natural terrain. Any disturbance of the natural terrain is balanced against the need for good drainage, economical construction and the safety of site personnel. Although the area designated as NRDS comprises about 93,000 acres, the actual area of operation is less than 15% of the acreage. The remaining 80,000 acres used as a buffer zone remain in their original state. The buffer zone provides the essential function of assuring a minimum separation distance between the test facility and uncontrolled private sectors. The overall effect on the land by the testing activities at the NRDS is therefore minimal and of transient importance except in the small areas occupied by the facilities, access roads and storage and disposal areas which occupy about 300 acres.

5.3 Waste Management

5.3.1 Non-Radioactive Wastes

Liquid Wastes - Liquid waste and sewage treatment systems in existence can adequately handle the present on-site population of about 200 people and will meet Federal and State water quality standards. Liquid wastes and sewage are disposed of through a system of drain tiles, septic tanks and sewage lagoons. The septic tanks depend upon natural bacteriological action to digest the sewage in the liquid. The overflow liquids are distributed to the soil through a tile field or, in some cases, routed into sewage lagoons. The majority of sewage is routed to lagoons which are associated with each major facility. Sewage lagoons also utilize bacteriological action. The alluvial characteristics of the soil, having zeolitic properties effectively contain the bio-degraded solids. In the desert environment moisture is depleted by evaporation at such a rate that there is no percolation into subsurface aquifers. Dikes and ditches protect against surface runoff from the lagoons in case of heavy rains. Sources of drinking water are monitored periodically for indications of pollution.

When the lagoons are retired from use, the surface terrain could be returned to normal by filling with material removed in the original excavation.

Solid Wastes - Solid wastes, consisting mainly of construction materials and paper, is disposed of through burial at the NRDS Solid Waste Disposal Area to the maximum practical extent. When burning is necessary to reduce volume, the residue is covered by back filling to return the terrain to normal. Those materials which have a salvage value are stored above ground for reuse or transfer off-site.

The quantity of material which is burned periodically averages about 100 pounds per day which is consistent with the Federal guidelines for burning wastes in non-urban areas.

5.3.2 Radioactive Wastes

Liquid Wastes - Radioactive liquid wastes containing mixed fission products are generated at the NRDS during decontamination of equipment and facilities. These wastes are piped to shallow sub-surface tile fields which serve the major facilities. The shallow tile field at Test Cell C where the Nuclear Furnace is to be tested lies within a small restricted area of about 3000 ft^2. Since the point of injection is about six feet below ground level, there is assurance that the nuclides cannot be liberated by such mechanisms as resuspension by wind and plant uptake. Also, diversionary channels are located around the tile field to control any possible erosion by flash floods.

Several studies have been conducted to determine the distribution of liquid radioactive waste from these tile fields, the rate of flow through the alluvium, and the depth of penetration[6,7,8]. Results show that the radioactive material is retained by ion exchange within a few feet of the point of injection. Recognizing that the alluvium extends to a depth of several hundred feet, these results indicate that the possibility of contamination of potable water supplies of underground water tables in Jackass Flats by surface waters is extremely remote. Neither on-site nor off-site water supplies have been or are expected to be affected by NRDS activities which comply with the requirements of the Federal Water Pollution Control Act.

If such tile field areas should be retired from use, the limited transmissibility through the soil and the fission product localization in a small area strongly limits the land area and soil volume that would have to be stabilized or decontaminated for return to alternate use. Therefore, there is no irreversible long term commitment to land use.

The radioactive liquid waste from Nuclear Furnace operations will not be channeled directly to the tile field. Rather, it will be directed to a hold-up tank from which it will be released to the tile field only after it is treated to reduce the concentration of radioactivity to levels well below those of Federal limits for drinking water.

Solid Wastes - Radioactive test equipment, used facility hardware, and other solid materials have been buried in a small fenced and restricted area near the R-MAD building. Contaminated rags and protective clothing are also buried in these areas. The total inventory is currently estimated to be less than 20 curies of mixed fission products and activation products. Extensive experience at this and other sites has demonstrated that water does not reach the depth at which waste is buried. Therefore, there is no mechanism for the transfer of radioactive material. The vast majority of this activity is firmly immobilized within solid materials (metals, concrete, insulated wiring, etc) which could be excavated and removed should it become desirable. However, dose rates at the surface are already less than .001 r/hr above background. Thus, excavation and removal may never become necessary. In either case, however, there is no long term commitment or irreversible use of the land utilized for burial of solid wastes.

5.4 Emissions from Heating Fuels

Although the NRDS is located in the desert region of the Southwestern United States, temperatures during the winter seasons require the burning of fuels to provide heat for the various facilities and buildings and for personnel comfort. The fuel which is used exclusively at the NRDS for heating purposes is No. 2 grade diesel fuel oil which has a low sulfur content consistent with recommended Federal guidelines.

5.5 Propellants and Gases

The ground testing of nuclear rockets requires the use of large quantities of hydrogen both in the liquid and gaseous form. The liquid hydrogen dewars at Test Cell C are capable of storing approximately 1.3 million gallons. Nitrogen and helium are also used during testing for cooling, inerting, and purging.

6.0 SPECIAL RADIOLOGICAL IMPACT AND PRECAUTIONS

It is expected that gaseous and liquid effluents from Nuclear Furnace testing will be sharply reduced by the exhaust gas and liquid waste cleaning systems to be employed. On the basis of previous experimental results, the fission product removal efficiency of the scrubber portion of the exhaust gas cleaning system is expected to be better than 90% except for the noble gases. The activated charcoal bed will remove most of the remaining iodines and some substantial fraction of the noble gases. The liquid waste system is expected to remove virtually all fission products except tritium. During the first set of NF-1 operations, the efficiency of both systems will be determined and this information will be utilized to assure that remaining NF-1 and NF-2 operations are conducted so that radiological effects will be small and well within Federal Guidelines 3, 4. The following analysis, therefore, relates to the upper limit for the first set of NF-1 operations i.e., 60 minutes at 40 MWt.

6.1 Fission Product Release

The extent of fission product release from the fuel elements has been estimated on the basis of laboratory experiments, reactor temperature profiles, and the knowledge of fission product behavior gained over the years of nuclear rocket testing. For the first set of power operations, it is conservatively assumed that 50% of the tritium and noble gases and 10% of the remaining products will diffuse from the fuel. For the purpose of providing a conservative estimate of the radiological effects of the airborne effluent, the fission product removal efficiency of the scrubber portion of the exhaust gas cleaning system is taken to be 90%. No credit is taken for the removal capability of the activated charcoal bed. Tritium, xenon and kypton are assumed to pass through completely and be discharged to the atmosphere. (Later in Par. 6.3, all the tritium released from the fuel is assumed to remain with the liquid waste rather than the gas phase). Peak activities of radioisotopes of particular interest are given in the following table for a 60-minute operation at 40 MWt. Activities are in curies.

Radioisotope	Activity Generated	Assumed Release From Fuel Elements Into Cleaning System		Assumed Release From Cleaning System (90% Efficiency)
I-131	2880	(10%)	288	29
Sr-90	5.16	(10%)	.516	.05
Cs-137	5.56	(10%)	.556	.05
Kr-85	.636	(50%)	.318	.17
Tritium	.044	(50%)	.022	.01

Release of discrete particles (three microns in diameter or greater) as observed in previous reactor tests is not expected from NF-1 and NF-2. Should such discrete particles be released from the fuel, they will be removed from the exhaust gas by the filter or the gas cleaning system or during passage to and through the flare stack. Therefore, discrete particles are not considered in the radiological effects analysis. Smaller particles may be released to the atmosphere. If so, they will behave as aerosols in the airborne effluent and are therefore included with the gases in the following analysis.

6.2 Downwind Dose Levels from Airborne Effluent

For typical NRDS weather conditions, the exposure levels at representative site boundaries of 15, 30 and 60 miles depending upon wind direction, are predicted to be as shown below. These estimates are for a 60-minute duration test and for the planned durations of NF-1 and NF-2, the values may be multiplied by 2 and 10 respectively.

	15 Miles*	30 Miles*	60 Miles*
Thyroid Inhalation	.2 mR	.06 mR	.02 mR
Thyroid Ingestion	1.7 mR**	.5 mR	.15 mR
Whole Body Dose	2.3 mR	.5 m	.12 mR

The thyorid inhalation dose considers all the iodines and assumes that the person exposed is of the most sensitive age, i.e., one year. Thyroid ingestion dose assumes that a child one year old drinks over a quart of milk per day from cows grazing on contaminated pasture. If feed on stored forage, the ingestion dose would be lower by a

* Representative distances to the boundaries of the government controlled complex for different wind directions. Fifteen miles is the closest distance to the south boundary.

**There are no dairy cattle at this distance, therefore value is hypothetical.

factor of five or more. All other organ doses are less than the guides [3,4] by a factor of at least a thousand.

6.2.1. Other Effects

Recent measurements show that concentrations of long lived strontium and cesium in NRDS surface soil range from 10 to 30 mCi/Km^2. These levels are actually lower than most areas of the United States. Analysis also demonstrates that even these low levels cannot be attributed solely to nuclear rocket testing.

Though a beryllium reflector is used in the reactor structure, no beryllium is released. The reactor core of enriched uranium is separated from the beryllium reflector by a hydrogen cooled gap which provides effective insulation. During power operations, the beryllium temperatures reach a maximum of 230°F. This is approximately 2100°F below the beryllium melting point; thus, there is no beryllium release to the environment. Post test examination of beryllium parts used in previous tests confirms this assessment.

The effluent gas cleaning system is also effective in restricting noise to very low levels (about 40 decibels at the foot of the flare stack -- much lower than normal conversational sound intensities).

6.3 Radiological Effects of Liquid Waste

As stated in 6.0 above, all of the products retained in the water phase of the exhaust gas cleaning system, except some of the tritium, are expected to be removed by the ion exchanger. The outlet line will be monitored and the flow automatically terminated if radioactivity above background is detected. If all of the tritium released from the fuel enters the water phase, the concentration of tritium would be 20 times lower than the maximum permissible concentration for drinking water at the time the water leaves the clean-up system and enters the tile field. Should any other fission products pass through the clean-up system, they would be retained in the soil within the tile field (see Sec. 5.3.2).

6.4 Effects of Accidents

In view of the many engineering safeguards used to assure safe reactor shut-down in case of a failure or error, the probability of a reactor accident is remote. Nevertheless, accidents and their effects are reviewed and analyzed for each nuclear rocket reactor and test circumstance. For any credible accident, insignificant amounts of new fission products could be generated (that amount produced in less than one minute of normal operation). The effect, rather, is to cause greater than normal amounts of the fission products already contained in the fuel elements to be released. Even so, the exhaust gas and liquid waste cleaning systems would continue to function effectively in all but the most improbable (worst case) circumstances. For the Nuclear Furnace, the worst case accident might result from a hydrogen explosion a severe earthquake, or a complete loss of coolant (both hydrogen gas and water) followed by release to the atmosphere of as much as 50% of the contained radioactivity. Radiation dose levels from gases and aerosols could, therefore, be about 100 mR at the nearest NRDS boundary. However, protective actions would be taken to minimize all exposures and thyroid dose from ingestion in particular (see 6.8 below).

6.5 Effects on Fish and Wildlife

Although the NRDS is a restricted area within which the location of humans is controlled during test periods to minimize exposure, similar control is not consciously exercised for wildlife. For Nuclear Furnace operations, however, maximum effluent concentrations during cloud passage which occur on-site at distances of 2 to 3 miles downwind and are usually no more than ten times those measured off-site. Moreover, current and predicted surface concentrations of long-lived strontium and cesium on the NRDS are actually lower than the National average. Early effluent effects on wildlife have never been observed and would not be expected at these low exposure levels. Some small probability of late effects may also exist. However, it has been repeatedly demonstrated that lower forms of animal life are more resistant to radiation than humans. In view of this, the limited number of animals which could be exposed, and the low dose levels, it is reasonable to conclude that such effects, if they exist at all, would not represent a significant impact on wildlife and would not threaten the survival of any species.

It is also recognized that fish and animals are capable of concentrating certain radionuclides in various body organs. Some of these represent steps in food chains not unlike that of human thyroid exposure from drinking milk from cows grazing on contaminated pastures. Increased radioiodine concentrations resulting from testing have been observed in the thyroids of ruminants, for example. On the other hand, strontium and cesium concentrations in cattle on the experimental farm at the Nevada Test Site have been found to be lower than those found in cattle of wetter habitats. Again, no biological effects from such exposures have been observed.

In a few cases, food chains involving wildlife end in man. However, there is no commercial fishing within 100 miles of the NRDS and raising and exploiting wild animals is prohibited by Nevada statute. Some species of wild birds (chukar, quail, and pheasant) are raised commercially in Las Vegas, some 82 air miles distant, and one must assume that some of these birds are eaten by man. Hunting is prohibited on the NRDS and the Nevada Test Site although game birds are hunted outside the borders. However, game laws limit the take and thus the possible consumption by man.

Considering these factors, there is no basis for suspecting a significant effect from nuclear rocket testing either on the wildlife itself or on man should wildlife be eaten by him.

6.6 Safety Review Procedures

A detailed safety analysis report is prepared for each new reactor type several months before its proposed testing at the NRDS. This report describes and analyzes the safety and radiological aspects of both the planned test program and all credible accidents. It is reviewed by the Space Nuclear Systems Office and by independent technical review groups in AEC's Division of Reactor Licensing. When satisfied that the proposed testing does not involve undue risk to the health and safety of test personnel and the off-site public, the AEC's Assistant General Manager for Reactors may approve the test series. All reactor testing is then conducted within the bounds of Technical Specifications and strict administrative controls.

6.7 Test Controls

Immediately prior to each reactor test, a final review is made by the Space Nuclear Systems Office and AEC's Nevada Operations Office. They are assisted by a panel with representation from the U. S. Department of Commerce, Air Resources Laboratory, EPA's Western Environmental Research Laboratory and other knowledgeable consultants and members in the fields of reactor technology, radiological health, biology and meteorology. Downwind radiological effects estimates are developed immediately prior to each test considering the current and forecast weather and the predicted fission product release from both the planned operation and the maximum credible accident. The estimates along with current information on the condition of the reactor including all safety and effluent cleaning systems are then used to assure that radiological effects from that day's test (maximum of one hour at power for Nuclear Furnace) will be as low as practical, and, in any event, below the Radiation Protection Guides. (Specifically, the annual dose limits of AEC Manual Chapter 0524 after reduction by the dose which may already have been received during the year from all testing at the NRDS and NTS.)

6.8 Protective Actions

The Manager of AEC's Nevada Operations Office is prepared to take protective actions as necessary or desirable. In particular, he is prepared to minimize thyroid ingestion dose by providing uncontaminated feed for dairy cows or by interrupting the milk chain. Consistent with the Federal Radiation Council's Protective Action Guides[10] the point at which protective actions are taken is decided on a case-by-case basis depending on a weighing of the projected dose to be avoided against the impact of the protective action.

7.0 COORDINATION WITH LOCAL AND STATE AND FEDERAL AGENCIES

The Western Environmental Research Laboratory provides an off-site radiological safety program for the Atomic Energy Commission in support of nuclear tests conducted at the Nevada Test Site (NTS) and the Nuclear Rocket Development Station (NRDS).

The Western Environmental Research Laboratory also maintains liaison with the Bureau of Radiological Health (BRH), U. S. Public Health Service and with the surrounding states. When any off-site radiological monitoring operation is conducted, all appropriate parties are kept advised and all state and BRH surveillance networks are alerted as appropriate to assist in documenting levels of radioactivity. Officials of neighboring states will be notified several days in advance of planned tests and again on the day of the test if it appears that test effluent is likely to cross their borders.

Insofar as the Federal Government is concerned, the Manager, Nevada Operations Office, Atomic Energy Commission, has the prime responsibility for the safety of personnel off the NRDS as this may relate to any on-site activities. He participates in the decision making process for reactor/engine tests conducted at the NRDS and aids in coordination between testing at the NRDS and the Nevada Test Site. He is prepared to take protective actions in concert with the Western Environmental Research Laboratory and state and local authorities.

Continuous coordination between the AEC and NASA is provided by the joint AEC/NASA Space Nuclear Systems Office responsible for the management of the Nuclear Rocket Program.

7.1 Public Information

A broad program of public information is in effect for NRDS tests. The Governor of Nevada and many Senators, Congressmen, and newsmen have toured the NRDS and witnessed tests. Prior to the conduct of a test series, a public announcement is issued by the Space Nuclear

Systems Office. After completion of the tests, public announcements are also made.

8.0 ALTERNATIVES

Realization of the potential advantages of nuclear rockets requires an arduous development process. However, there are many alternative approaches to development. The approach selected emphasizes rigorous engineering analysis coupled with extensive testing at the materials, parts, and components levels prior to full scale engine testing. This approach is believed to be the most effective, the most economical, and to have the least environmental impact. (See Sec. 1.0)

Facility equipment which might further reduce environmental impact has been proposed and investigated since the beginning of the testing program. Many of these concepts have been adopted such as the exhaust gas and liquid waste cleaning systems described. The exhaust gas cleaning system is actually expected to be much more efficient than the values used for computing downwind dose levels (80% for iodine and zero for noble gases). Therefore, potential thyroid doses are actually expected to be considerably lower than the levels presented in paragraph 6.2. Higher efficiencies were not assumed, however, so as to assure conservative potential dose estimates and because the small amount of methane in the effluent may limit the absorptive capacity of the existing charcoal bed. It is believed that the efficiency of the charcoal could be improved by increasing the size of the bed and/or by further reducing the effluent gas temperature between the scrubber portion and the charcoal bed. Both of these alternatives would involve the purchase, installation, instrumentation, and activation of new equipment with attendant costs and program delays. In view of the very low thyroid dose levels actually expected, however, and the fact that bone and whole body dose from noble gases and their daughters will be less than one tenth of one percent of the guides in any case, it is not proposed to adopt these alternatives, at least for NF-1. During the testing of NF-1, efficiencies and downwind air concentrations will be measured. If the overall efficiency of the effluent gas cleaning system does not prove up to expectations, these alternatives will be reconsidered.

The NRDS is part of a large government controlled complex already committed to nuclear rocket development testing. Largely because of its remoteness and minimum environmental impact, the NRDS is entirely adequate for the purpose. Other sites have been investigated and found less suitable because of inferior facilities and increased environmental impact.

9.0 LONG TERM VS. SHORT TERM LAND USE

Although there was no known use of the land previously, the use of the NRDS for nuclear rocket testing does not detract from the long range use and productivity of the land for agriculture, mining, or recreation. Surface radiation levels of long lived fission products on the NRDS from all sources range from 10 to 30 millicuries per square kilometer, lower than in most parts of the U. S. (Only a small part of this can be attributed to nuclear rocket testing.) Therefore, surface radiation levels would not preclude the use of the land for other purposes. Facilities and small shallow volumes of soil (no more than 3000 cubic yards) containing solid and liquid waste could be removed if that should ever become desirable. (See Sec. 5.3.2)

10.0 IRREVERSIBLE AND IRRETRIEVABLE USE OF RESOURCES

Nuclear rocket testing during FY 1972 does not involve the irreversible and irretrievable commitment of resources. It does require the near term occupancy and control of 93,000 acres to assure maximum protection of the public. Beyond this land utilization, however, the proposed action does not curtail any other beneficial use of the environment.

11.0 CONCLUSION

The exploration and utilization of space has already provided many important benefits to man such as improved mapping, communications, weather forecasting, and increased knowledge of the Earth and Solar System. For these reasons, the Congress and the Administration propose to continue a progressive space program. Utilization of the increased efficiency of nuclear rockets can provide adequate payloads for extended space exploration at lower cost than conventional rocket vehicles. A program to develop the potential of nuclear rockets has, therefore, been underway for several years.

One of the most difficult technical tasks involved in achievement of nuclear rockets is the development of very high temperature fuel elements capable of reliable performance during many hours of operation at full power. Testing under a realistic nuclear environment is essential to this end and it has been demonstrated that Nuclear Furnace provides the most economical means at the least environmental cost.

The proposed action does involve the unavoidable release to the environment of small quantities of radioactive fission products which result in potential dose levels off-site of 2 to 4% of the Federal radiation standards. It also involves short term occupancy and control of 93,000 acres.

Consideration of the alternatives available led to the adoption of a development philosophy which minimizes the requirements for full scale reactor testing and emphasizes fuel element testing in Nuclear Furnace at one fortieth of full power. The alternative of providing various facility equipment to further reduce fission product release was explored and resulted in the adoption of effluent gas and liquid waste cleaning systems which are expected to be very effective.

In balancing the benefits of fuel element testing in Nuclear Furnace during FY 1972 against the environmental costs described above, and considering the alternatives available, the U. S. Atomic Energy Commission and the National Aeronautics and Space Administration have concluded that the proposed course of action should be implemented.

NUCLEAR FURNACE - FLOW SCHEMATIC

(NOT TO SCALE)

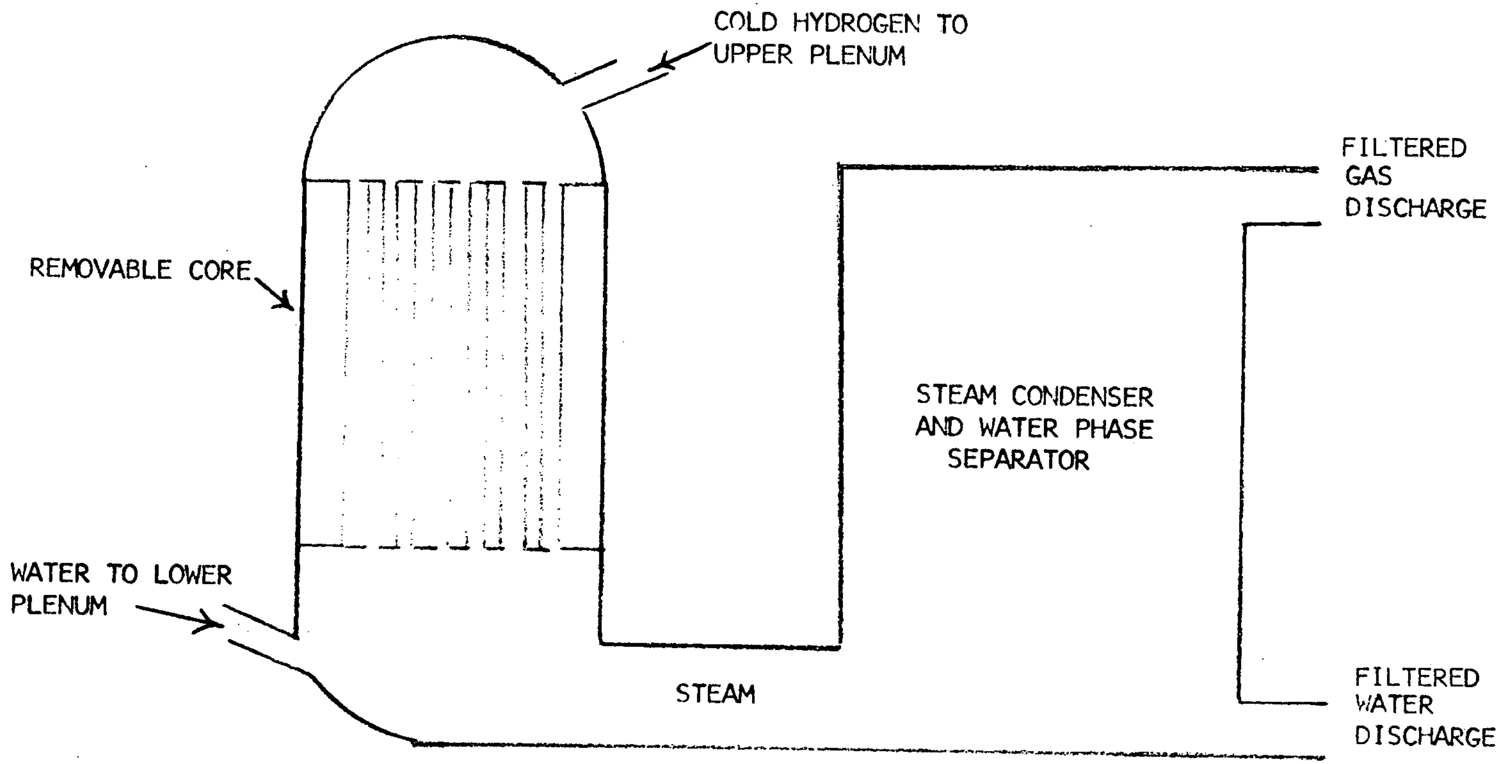
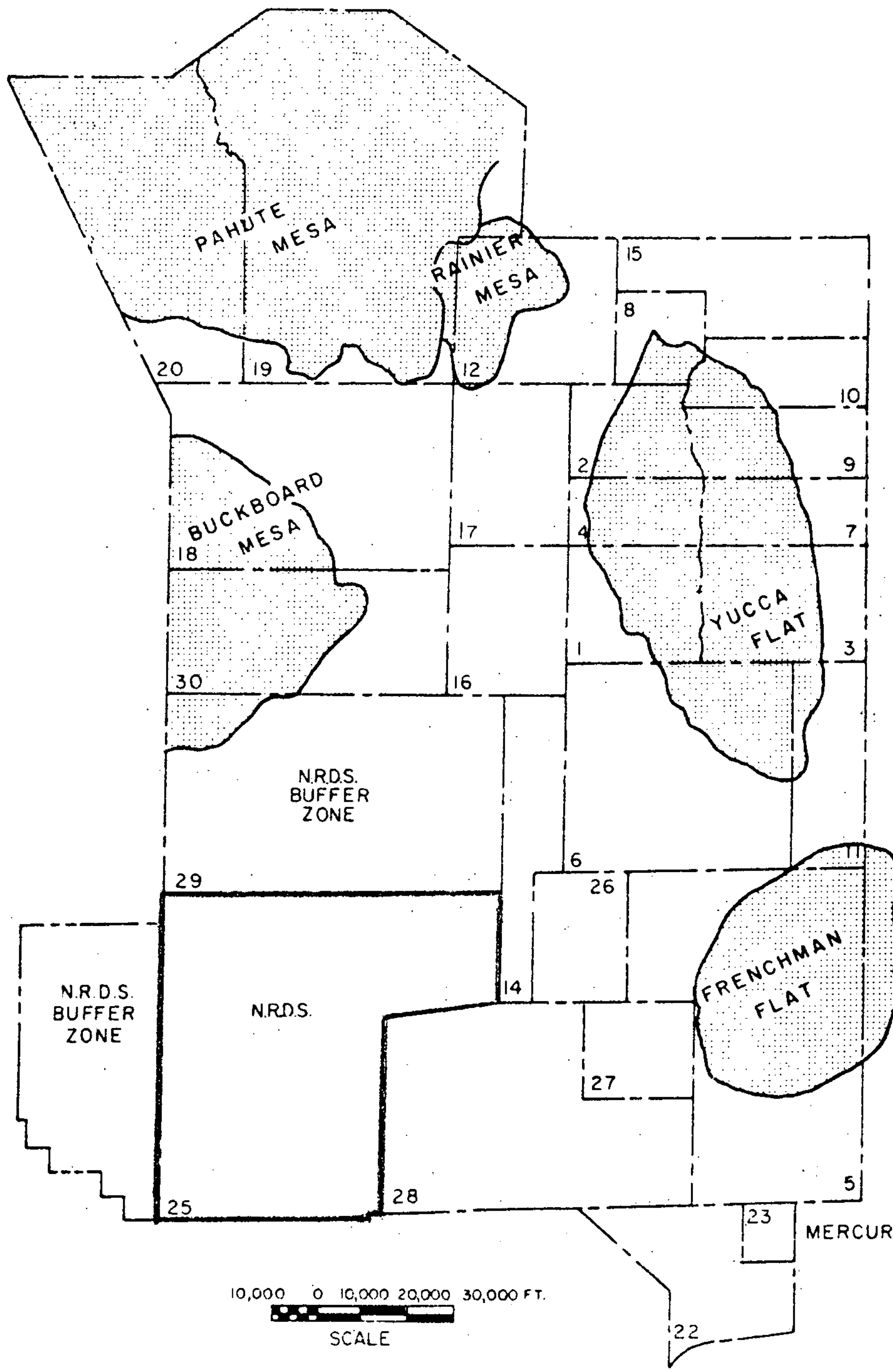


FIGURE 1

LOCATION MAP-NEVADA TEST SITE (NTS)

FIGURE 2



RELATIONSHIP OF NRDS TO NTS

FIGURE 3

NUCLEAR ROCKET DEVELOPMENT STATION LAYOUT

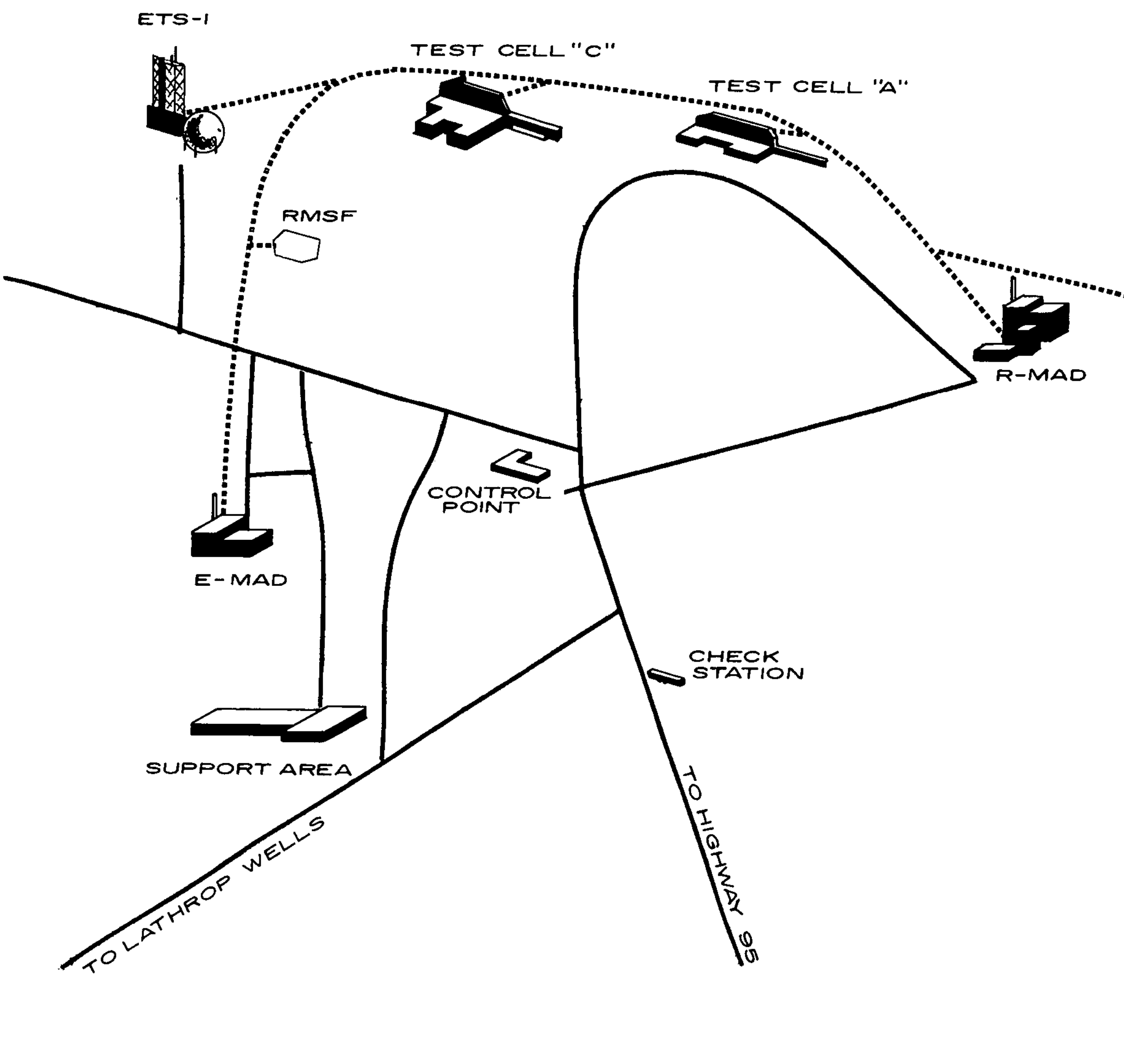


FIGURE 4

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    b. Particulate Effluent Study for Phoebus 1B, SWRHL 46r.

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9. Operations Plan for Reactor/Engine Tests at the NRDS, Space Nuclear Propulsion Office, Nevada Extension, 1970.

10. Radiation Protection Standards, Federal Radiation Council Reports 5 and 7.

ANNEX A

BIOENVIRONMENTAL STUDIES OF THE NEVADA TEST SITE

Since the inception of the testing activities at the NTS, at least 25 organizations have conducted biological and environmental studies in the area occupied by the site. Federal and state agencies and university, industrial and private research organizations have all worked on environmental problems related to the testing program. Many of the studies have been designed mainly to describe the desert biosphere.

Briefly, the scope of bioenvironmental information that has been developed within the various disciplines is as follows:

Geology

Geological studies of the Test Site have been in progress by teams of earth scientists from the U. S. Geological Survey and various institutions since 1956. Due to this effort, surface and underground geological characteristics of the Test Site are reputedly better known than any other area of comparable size in the U. S.

Climatology

Studies by NOAA (and its predecessor organizations) of the climatology of the NTS areas have been in progress since 1956. Much has been learned about the general weather characteristics of the area and of the influences of topography and solar insolation on local wind regimes. The latest climatological summary of the NTS was published in August 1968.

Floristic Surveys

Because the region encompassed by the Test Site was rarely visited by biologists in pretest times, there was little background information on the flora and fauna of the area. Studies conducted by plant ecologists and taxonomists from the UCLA, with the assistance of botanists from many other institutions, have subsequently developed extensive knowledge of the Test Site's plant life. There have been identified 527 taxa of vascular plants representing 239 genera, and specimens are on file in the NTS herbarium, as well as in university herbaria. Other floristic studies have been devoted to studies of soil algae and other micro flora. Plant communities on the Test Site have been identified and their distributions mapped.*

*Beatly, Janice E., "Vascular Plants of the Nevada Test Site, Nellis Air Force Range and Ash Meadows", UCLA-12-705 (March 1969).

Faunistic Surveys

Among the vertebrates that inhabit the Test Site are 43 species of mammals, 188 species of birds, and 29 species of reptiles. This count for mammals does not include mustangs and wild burros, several small bands of which reside on the Site.*

The game species of mammals include mule deer, mountain lion, occasional antelope, and Desert Bighorn Sheep. The game birds include chukar partridge, Gambel's quail, mourning doves, and small numbers of various waterfowl that stop at the small water sources during migration. The mule deer population is estimated to be about 2,500 animals. The entire Test Site area is closed to hunting.

The association of animals with plant communities on the Site have been identified and reported and comparable identifications have been made of the biotic communities of the Mojave Desert region surrounding the Test Site by Brandly and Deacon (1965).

Radioecological and Radiobiological Studies

Laboratory and domestic plants and animals, native species, and natural biotic communities have been used in controlled experiments and studied under actual conditions resulting from nuclear detonations to develop predictive capability and to evaluate the effects of nuclear testing upon plant and animal life. These studies have included both investigations of the interception, biological accumulation and retention of specific radionuclides by plants and animals, and studies of the effects from radiation.** Most of the radiobiological studies conducted in direct support of nuclear testing on the NTS are conducted under AEC contract by the Lawrence Radiation Laboratory of the University of California at Livermore; the Southwestern Radiological Health Laboratory of the EPA; the University of California at Los Angeles; and by biologists of EG&G, Inc.

Searches for radionuclides in native organisms and agricultural regions in the environs surrounding the NTS are conducted mainly by the Southwestern Radiological Health Laboratory, the Lawrence Radiation Laboratory and the University of Utah.

In addition to this effort, a large part of the biological and medical research conducted at various universities and other institutions under funding from the Division of Biology and Medicine, AEC Headquarters, contributes invaluable information which is continuously used to improve

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* Beck, D. E. and Allred, D. M. "BYU Ecological Studies at the Nevada Test Site, 1959-1966", Great Basin Naturalist, Vol. 28 (3) (1968).

** Shultz, Vincent, "References in Nevada Test Site Ecological Research", Great Basin Naturalist, 26:3-4, December 31, 1966.

abilities to predict and evaluate effects and to improve radiological safety. During the past 25 years over one billion dollars in research effort within the United States has gone into the study of the biological and ecological effects of radiation and radioactivity.

Many of these experiments and studies have been completed but some are still in progress. None of these investigative projects has revealed significant adverse radiological effects on plant or animal life from underground nuclear testing at the NTS. These efforts are continuing in areas where further study appears needed.

ANNEX B

COMMENTS RECEIVED ON DRAFT ENVIRONMENTAL STATEMENT

AND AEC RESPONSES

United States Department of the Interior

OFFICE OF THE SECRETARY
WASHINGTON, D.C. 20240

SEP 9 1971

Dear Mr. Erlewine:

This is in reply to your letter of July 2, 1971, requesting our comments on the draft environmental statement on the AEC-NASA FY 1972 Reactor Testing Program at the Nuclear Rocket Development Station, Nevada. The statement has been reviewed by several units within the Department and their comments are incorporated in this letter.

We find this statement is more informative than that on the FY 1971 program which we reviewed earlier this year but believe that sufficient detail is not yet given on fish and wildlife, waste disposal, and land use.

Specific comments, keyed to the sections in the draft report, are as follows:

2.1 Nuclear furnace description: A more complete description of the materials used to construct the nuclear rocket engine and its enclosure is desirable. It is well known that hydrogen embrittles most steels as well as some other materials. Therefore, the knowledge that proper allowance is made for the embrittlement of materials, or that the materials used do not embrittle, would be reassuring.

The use of hydrogen could also result in an explosion if oxygen is present in the vicinity of the high-temperature reactor core. Potential sources of this oxygen are: (1) oxygen contained in the hydrogen; (2) dissociation of water used to trap tritium; and (3) back diffusion of oxygen from the exit. A question also arises as to the problems resulting from a sudden pressure decrease at the hydrogen inlet which would cause a decrease in the hydrogen flow rate. The consequent increase in the core temperature could in turn result in the reactor core melting.

3.4 Seismology: We note that all facility structures have been strengthened to withstand a Zone 3 magnitude earthquake, but we wonder what adverse effect, if any, an earthquake of high magnitude might have on the radioactive material storage facility, in particular that storage which is on railroad cars. The final statement should include information regarding the possibility of such an occurrence and the inherent dangers.

5.3.1 Non-radioactive wastes: Though contamination of water sources is said to be not possible through percolation of sewage effluent because of the high evaporation rate in the area, is such contamination possible during rainstorms? Are water supplies in the area monitored for radioactivity and/or biological pollution increases?

5.3.2 Radioactive wastes: Radioactive liquid wastes contain mixed fission products, including Sr-90 and Cs-137, both of which have long half-lives. The statement indicates that these wastes will be held in tanks and released to the tile drain field areas only after they are treated to reduce the concentration of radioactivity to acceptable levels. The level of concentration that is acceptable should be specified.

Further, if radioactive material will be retained in the tile drain fields within a few feet of the point of injection, as studies indicate, it would seem prudent to consider the conditions under which the ion-exchange capacity of the earth materials below the tile drain areas might be exceeded, and the consequences from the standpoint of underground migration of wastes. The activity in these wastes will be at a significant level for as much as 1,000 years. Despite the plan to introduce the wastes to the tile drain fields at some "acceptable level," the retention of the waste locally by ion exchange in the drain fields will reconcentrate the activity.

Is the radioactive life of the buried solid wastes greater or less than the usable life expectancy of the metal, concrete, and other materials enclosing them? If greater, the paragraph should be expanded to include consideration of this factor. If less, perhaps that fact should be noted.

6.2 Downwind dose levels from airborne effluent: The draft statement indicates that the fission product removal efficiency of the exhaust gas cleaning system is taken to be 80 percent except for tritium and the noble gases, which are assumed to pass through completely. The tritium is assumed to remain with the liquid waste phase, which implies that the radioactive noble gases are emitted to the atmosphere. Although the data given on pages 20 and 21 give assurance that the radioactive noble gases would not harm humans or animals over the short term, the long-term effects of these radioactive noble gases should be delineated.

As most research on the biological effects from radiation exposures have been centered around the safety of humans, we cannot evaluate what effects this project may have, if any, on the ecological factors of the natural environment surrounding units of the National Park system. The nearest unit is Death Valley National Monument, which is 45 miles southwest of the project site.

6.5 Effects on fish and wildlife: The statement does not adequately describe the impact of nuclear rocket testing on fish and wildlife resources and the environment. There is insufficient detail given to permit a full analysis of the testing program, to demonstrate that all environmental effects have been considered and that the best possible plan for the protection of the environment has been developed, and to verify the conclusion on page 22 that the effects of the effluent, if any, would not have a significant impact on fish and wildlife resources nor threaten the survival of any species.

Though the list of fauna in 3.7 includes most of the species mentioned in our comments on the F.Y. 1971 draft statement, it does not point out that the desert tortoise is an endangered species, nor does it include the Devils Hole pupfish and Pahrump killifish, both endangered species, which occur within 50 miles of the area.

Though air, water, soil, vegetation, cattle, and milk are being monitored, there is no indication that fish and wildlife are included in the sampling program, that pre-program sampling was conducted to determine base-level radioactivity in the fish and wildlife species and their habitat, or that the monitoring was designed to determine radiation buildup that may be harmful to fish and wildlife or the environment as the result of the testing. If such monitoring is underway, the details of the program should be appended to the statement to demonstrate that adequate sampling of representative fish and wildlife species is being conducted at appropriate intervals. If not, the radiological monitoring program should be revised so that representative species are included. We recommend that such sampling be conducted every six months, or at appropriate intervals following significant testing activities, until it has been demonstrated conclusively that no significant environmental damage has occurred.

We are concerned with the long range and accumulative effects of radionuclide buildup in animals and their habitat. If damages occur, the testing program should be adjusted to reduce the detrimental effects to acceptable levels. If no significant damage is detected, consideration could be given to opening the 80,000-acre portion of the area not actually used for testing to public access for hunting and related purposes. The Nevada Department of Fish and Game, the State agency primarily responsible for the management of the fish and wildlife resources of the State, should be contacted for assistance in developing guidelines for use of the area by the public for hunting and related purposes consistent with the continuation of the testing program.

Noise from rocket testing does not now appear to be a major problem, but increases in the frequency or duration of testing may produce noise levels that could be damaging to some wildlife species, especially during critical seasons such as breeding, nesting, and migration.

We recommend that the final environmental statement be expanded to include the suggestions outlined above. We would be pleased to work with your agency and the Nevada Fish and Game Department in accomplishing this end.

7.1 Public Information: A broad program of public information is in effect for NRDS tests, but no information is given on public reaction and comments received either as a result of public meetings or from press accounts of previous activities.

We appreciate the opportunity of commenting on this statement and hope that our suggestions will be helpful in preparing the final environmental statement.

Sincerely yours,

Assistant Secretary of the Interior

Mr. John A. Erlewine
Assistant General Manager
for Operations
Atomic Energy Commission
Washington, D. C. 20545

UNITED STATES
ATOMIC ENERGY COMMISSION
WASHINGTON, D.C. 20545

DEC 3 0 1971

Honorable John W. Larson
Assistant Secretary of the Interior
U. S. Department of the Interior
Washington, D. C. 20240

Dear Mr. Larson:

We have carefully considered the comments in your letter of September 9, 1971, on the Draft Environmental Statement on the AEC-NASA FY 1972 Reactor Testing Program at the Nuclear Rocket Development Station, Nevada.

Since your specific comments are keyed to the sections in the draft report, our responses are similarly keyed.

2.1 <u>Nuclear Furnace Description</u>

We are aware of the problem of hydrogen embrittlement and proper allowance has been made in our reactor and facility designs.

The possibility of hydrogen fires or explosions has always been recognized in nuclear rocket testing. Designs are such as to minimize their occurrence and effective countermeasures have been developed and utilized. Should fires or explosions occur in spite of these safeguards, radioactive material would not be released in most cases. It is recognized that the exhaust gas cleaning system could be defeated by a hydrogen explosion under certain unlikely circumstances, however. This event, and the complete loss of coolant accident resulting in core overheating, are included in the "worst case accident" category referred to in the draft. Paragraph 6.4 has been modified to make this clear.

3.4 <u>Seismology</u>

It is possible that a high magnitude earthquake might overturn the flatbed railroad cars on which fuel elements are stored. However, the remaining fission products are tightly bound in the fuel elements and no mechanism is envisioned to cause their release to the environment. The fuel elements themselves would of course be picked up again and repackaged. Since no environmental impact is envisioned, the statement has not been modified.

5.3.1 Non-Radioactive Wastes

This paragraph has been modified to state that ditches and dikes are used to prevent breach of containment of sewage lagoons during flash floods and that potable water is sampled periodically for evidence of pollution.

5.3.2 Radioactive Wastes

The paragraph has been rephrased to state that it has been practicable to design a treatment process such that strontium and cesium will be removed from the water before release to the tile field. Considering the low levels of radioactivity which could conceivably pass through the liquid waste cleaning system, it is inconceivable that the ion exchange properties of the earth materials in and below the tile field could be exceeded.

The great absorptive capacity of the underlying soils at NRDS has been investigated and verified over a period of years. References 6 and 8 give detailed results of column studies performed for us by the Department of Interior and the Atomic Energy Commission. Additionally, on-site samples taken on and within existing tile drain fields by our contractors resulted in the statement that material injected in the past into tile drain fields has stayed within a few feet of the point of injection. We anticipate no situation under which the capacity of the underlying soils will be exceeded.

There are no enclosures made of metal, concrete or other materials surrounding buried solid waste. The solid waste is buried in open ditches and covered with local soil. All of the radioactivity is contained within the solid material and protected from reaction from the relatively arid, dry environment. We foresee no mechanism for release of the radioactivity from the solid waste.

6.2 Downwind Dose Levels from Airborne Effluent

The statement that "all other organ doses are less than the guides by a factor of at least a thousand" includes consideration of long term biological effects of the long lived noble gases (primarily Kr85) and the long lived daughters of the noble gases (Sr-89, Sr-90, Y-91, Cs-137, and Ba-140/La-140).

6.5 Effects on Fish and Wildlife

You will note that additional paragraphs have been added under 6.2.1 to cover other effects, i.e., surface concentration of long lived radionuclides and noise. Obviously, any possible effect on wildlife resulting from surface concentrations of long lived strontium and cesium will be lower on the NRDS and environs than in other, less arid parts of the country.

During most previous nuclear rocket testing at the NRDS, the hot hydrogen was exhausted to the atmosphere at very high velocity through a supersonic nozzle. Noise resulted from the shear between the exhaust jet and the surrounding air. The Nuclear Furnace does not employ a supersonic nozzle, however. Rather, the exhaust hydrogen gas is slowed down, cooled, cleaned and then routed through a flare stack where it is burned at very low velocity. Therefore noise levels during testing will be very low.

While 80,000 of the total 93,000 acres of the NRDS is not actively occupied, it is nevertheless essential in assuring public health and safety. Effluent radiological effects drop off rapidly with increasing distance from the reactor during testing. This area therefore provides a minimum separation distance and assures low radiation levels off-site. The criterion for its proper utilization, therefore, is not that wildlife is not harmed but that maximum practical protection is provided for human beings.

7.1 Public Information

In accordance with the CEQ guidelines, the draft environmental statement was made available to the public. Although several copies were requested and provided, no comments have been received other than those from States and agencies. These letters are appended to the final statement. We are not aware of any unfavorable public reaction to the proposed testing described in the FY 1972 statement or to any general adverse reaction to previous testing.

We appreciate the effort made by the Department of the Interior in reviewing the statement and thank you for the comments. We have noted in this letter where the statement will be revised as a result of your efforts.

Sincerely,

John A. Erlewine

John A. Erlewine
Assistant General Manager
for Operations

DEPARTMENT OF AGRICULTURE
OFFICE OF THE SECRETARY
WASHINGTON, D. C. 20250

July 21, 1971

Mr. John A. Erlewine
Assistant General Manager
for Operations
Atomic Energy Commission
Washington, D. C. 20545

Dear Mr. Erlewine:

The draft environmental impact statement for Reactor Testing During FY 1972 at the Nuclear Rocket Development Station, Nevada (NRDS) has been reviewed. We believe that the environmental impact on man, animals, and agriculture will be minimal and it is recommended that nuclear rocket reactor testing proceed as planned at NRDS during fiscal year 1972.

Sincerely,

T C Byerly

T. C. BYERLY
Assistant Director
Science and Education

UNITED STATES
ATOMIC ENERGY COMMISSION
WASHINGTON, D.C. 20545

DEC 30 1971

Mr. T. C. Byerly
Assistant Director
Science and Education
Department of Agriculture
Office of the Secretary
Washington, D. C. 20250

Dear Mr. Byerly:

Thank you for your comments of July 21, 1971, on our Draft Environmental Statement for Reactor Testing during FY 1972 at the Nuclear Rocket Development Station, Nevada. We have since revised the statement, taking into account the comments received on the draft. For your information, we enclose copies of the final statement, the comments received, and our response to the comments.

Sincerely,

John A. Erlewine

John A. Erlewine
Assistant General Manager
for Operations

Enclosures:
1. Final NRDS Statement
2. Comments on Draft Statement
3. AEC Response to Comments

OFFICE OF THE SECRETARY OF TRANSPORTATION
WASHINGTON, D.C. 20590

ASSISTANT SECRETARY

JUL 29 1971

Mr. John A. Erlewine
Assistant General Manager
for Operations
Atomic Energy Commission
Washington, D. C. 20545

Dear Mr. Erlewine:

We appreciate the opportunity to review the environmental impact statement for Reactor Testing During FY 1972 at the Nuclear Rocket Development Station - Nevada (NRDS). However, since this project appears to have no transportation impact, we have no comments to offer.

Sincerely,

Herbert F. DeSimone
Assistant Secretary for
Environment and Urban Systems

UNITED STATES
ATOMIC ENERGY COMMISSION
WASHINGTON, D.C. 20545

DEC 3 0 1971

Mr. Herbert F. DeSimone
Assistant Secretary for
Environment and Urban Systems
Department of Transportation
Washington, D. C. 20590

Dear Mr. DeSimone:

Thank you for your letter of July 29, 1971, concerning the AEC's and NASA's Draft Environmental Statement for Reactor Testing during FY 72 at the Nuclear Rocket Development Station, Nevada. Since that time, we have revised the statement, taking into account the comments received on the draft. For your information, we enclose copies of the final statement along with comments received, and our response to the comments.

Sincerely,

John A. Erlewine

John A. Erlewine
Assistant General Manager
for Operations

Enclosures: (2 cys)
1. NRDS Final Statement
2. Comments on Draft Statement
3. AEC Response to Comments

DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
OFFICE OF THE SECRETARY
WASHINGTON, D.C. 20201

AUG [illegible] 197[illegible]

Mr. John A. Erlewine
Assistant General Manager
for Operations
U.S. Atomic Energy Commission
Washington, D.C. 20545

Dear Mr. Erlewine:

The Draft Environmental Statement for Reactor Testing During FY 1972 at the Nuclear Rocket Development Station sent with your letter of July 2, 1971, has been reviewed within this Department.

Based on information contained in this statement, it appears that the planned test program can be conducted without undue impact on the environment or an unacceptable hazard to the public health and safety.

I would appreciate receiving your evaluation of the fission product removal efficiency of the exhaust gas cleaning system of the Nuclear Furnace following the first set of NF-1 tests.

Sincerely yours,

Merlin K. DuVal

Merlin K. DuVal, M.D.
Assistant Secretary for
Health and Scientific Affairs

UNITED STATES
ATOMIC ENERGY COMMISSION
WASHINGTON, D.C. 20545

DEC 30 1971

Merlin K. DuVal, M.D.
Assistant Secretary for Health
and Scientific Affairs
Department of Health, Education
and Welfare
Washington, D. C. 20201

Dear Dr. DuVal:

Thank you for your comments of August 5, 1971, on our Draft Environmental Statement for Reactor Testing during FY 1972 at the Nuclear Rocket Development Station, Nevada. We have since revised the statement, taking into account the comments received on the draft. For your information, we enclose copies of the final statement, the comments received, and our response to the comments.

We will be happy to provide you with our evaluation of the fission product removal efficiency of the exhaust gas cleaning system of the Nuclear Furnace following the first set of NF-1 tests.

Sincerely,

John A. Erlewine

John A. Erlewine
Assistant General Manager
for Operations

Enclosures:
1. Final NRDS Statement
2. Comments on Draft Statement
3. AEC Response to Comments

THE ASSISTANT SECRETARY OF COMMERCE
Washington, D.C. 20230

September 20, 1971

Mr. Christopher L. Henderson
Assistant Director for Regulation
Atomic Energy Commission
Washington, D.C. 20330

Dear Mr. Henderson:

Please refer to the draft environmental statement, "Reactor Testing During FY 1972 at the Nuclear Rocket Development Station, Nevada," which was forwarded for our review by Mr. Erlewine's letter of July 2, 1971.

The enclosed comments, just received from the National Oceanic and Atmospheric Administration of the Department of Commerce, are presented for your consideration in preparing the final environmental impact statement.

I apologize for our not meeting your August 2 deadline.

Sincerely,

Sidney R. Galler

Sidney R. Galler
Deputy Assistant Secretary
for Environmental Affairs

COMMENTS RELATIVE TO THE DRAFT
7107.09 NUCLEAR ROCKET DEVELOPMENT STATION, NEVADA

The draft document represents an evaluation of certain aspects of the environmental impact, including ground motion and building response evaluations in which the National Ocean Survey has an interest and is in general agreement. Our involvement with this phase of the Nevada Test program, since its inception, provides a comprehensive background from which this evaluation can be derived. However, there are other portions of the draft statement that require further consideration.

The "Earthquakes" section is too brief, particularly in regard to the seismic history, and there is no evidence of the utilization of other source material such as earthquake catalogs of Nevada (Slemmons, et al, 1965) or journal articles which indicate that central Nevada is more seismically active than the San Andreas Fault Zone (Slemmons, et al, 1965) and western Nevada. Two seismic zones which are important to this evaluation have not been mentioned. One, trending approximately N-S, lies to the east of the Sierra Front zone in the western Basin and Range province and passes to the west of NTS and the Supplemental Test Site (STS). The second, a weaker zone, curves across southern Nevada and Utah and joins the Rocky Mountain zone. Several large earthquakes which have occurred in central Nevada north of NTS (Richter, 1956) and closer to STS have not been referenced (See maps). Gross association of earthquake activity with fault structure is not as obvious in Nevada as in California, hence the need for microearthquake studies. The studies performed thus far have been quite informative (Oliver, et al, 1966; Westphal and Iange, 1967; Stauder and Ryall, 1967), and should be extended.

Evaluation of the geology of the Test Site is given scant attention. Brief reference is made to local conditions such as cavity and subsequent collapse generation, and to the motion along local zones of weakness in the rocks (faults), but nothing is written on the regional aspect of geology. The extensive studies of the geology of NTS have shown that there are numerous faults, folds, and flexures on the test site. A north-south lineation of these features is predominant in both eastern and western Nevada. The Late Quaternary Pleasant Valley, Fairweather, and Fallon-Stillwater faults in western Nevada have exposed traces of fifty miles or more and very large historical earthquakes associated with them. In eastern Nevada there are similar structures such as the Yucca Fault with some 50 miles or more of mappable traces and the Desert

Range fault zones of similar length. However, the overall picture is one of considerable complexity. As a result, many assumptions, such as propagation velocities, and rates of attenuation, which are by necessity based on isotropic homogeneous media, may or may not be valid.

The existence of major fault structures in Nevada raises the question of what the maximum credible earthquake in the area could be. Certainly, the historical activity in Western Nevada indicates a potential for very large events. What the maximum potential earthquake could be in eastern Nevada and what effect it could have on the nuclear test program and hence on the environment should be considered.

SPACE NUCLEAR SYSTEMS
U.S. ATOMIC ENERGY COMMISSION
WASHINGTON, D.C. 20545

DEC 30 1971

Dr. Sidney R. Galler, Deputy Assistant
Secretary for Environmental Affairs
The Assistant Secretary of Commerce
Washington, D. C. 20230

Dear Dr. Galler:

Thank you for the comments of the Department of Commerce forwarded by your letter of September 20, 1971. We have since discussed them with members of the Environmental Research Laboratory in Rockville.

We recognize that an earthquake at the Nuclear Rocket Development Station might well result in structural damage to the Nuclear Furnace and the test facility. If it were to occur during a test at power, the likely result would be the release of some large fraction (up to 50%) of the fission product inventory accumulated during the test. It must be recalled, however, that the Nuclear Furnace operates at very low power (40 MWt) for no more than one hour in any one test day. Hence, the potential release is very low in comparison with a modern nuclear electric plant operating continuously at 2000 - 3000 MWt. Therefore, the most adverse result would be potential dose levels at the closest Station boundary well below that considered safe for normal (non-accidental) operations.

For this reason and because the environmental statement was already in final processing at the time your comments were received, we have not modified the statement to include the additional information you have provided. However, the discussion of accidents has been modified to recognize an earthquake as a possible cause of the "worst case" accident.

Thank you for your careful review and suggestions.

Sincerely,

John A. Erlewine

John A. Erlewine, Assistant General
Manager for Operations

Enclosures:
1. Final NRDS Statement
2. Comments on Draft Statement
3. AEC Response to Comments

ARIZONA DEPARTMENT OF
ECONOMIC PLANNING AND DEVELOPMENT
3003 NORTH CENTRAL AVENUE • SUITE 1704 • PHOENIX, ARIZONA 85012 • (602) 271-5371

July 29, 1971

Mr. John A. Erlewine
Assistant General Manager
for Operations
U. S. Atomic Energy Commission
Washington, D. C. 20545

Re: Draft Environmental Statement for
Reactor Testing During FY 1972
at the Nuclear Rocket Development
Station - Nevada.

Dear Mr. Erlewine:

The Arizona State Clearinghouse has had opportunity to review the above mentioned project submitted by the Atomic Energy Commission.

Clearinghouse review procedures have indicated that no adverse effects should be experienced by the State of Arizona. The Arizona Atomic Energy Commission concurs with your proposal as submitted.

We feel that this submission conforms to current requirements as set forth in Office of Management and Budget Circular A-95 Revised.

Thank you for this opportunity to comment.

Sincerely,

Robert G. Worden
Executive Director

MG:js

UNITED STATES
ATOMIC ENERGY COMMISSION
WASHINGTON, D.C. 20545

DEC 3 0 1971

Mr. Robert G. Worden
Executive Director
Department of Economic Planning
and Development
3003 North Central Avenue
Suite 1704
Phoenix, Arizona 85012

Dear Mr. Worden:

Thank you for your comments of July 29, 1971, on our Draft Environmental Statement for Reactor Testing During FY 1972 at the Nuclear Rocket Development Station, Nevada. We have since revised the statement, taking into account the comments received on the draft. For your information, we enclose copies of the final statement, the comments received, and our response to the comments.

Sincerely,

John A. Erlewine

John A. Erlewine
Assistant General Manager
for Operations

Enclosures:
1. Final NRDS Statement
2. Comments on Draft Statement
3. AEC Response to Comments

cc: Honorable Jack Williams
Governor of Arizona
w/Encls.

STATE OF **COLORADO** DEPARTMENT OF **HEALTH**

4210 EAST 11TH AVENUE • DENVER, COLORADO 80220 • PHONE 388-6111

R. L. CLEERE, *M.D., M.P.H., DIRECTOR*

July 28, 1971

Mr. John A. Erlewine
Assistant General Manager
for Operations
Atomic Energy Commission
Washington, D. C. 20545

Dear Mr. Erlewine:

The draft environmental statement for reactor testing during fiscal year 1972 at the Nuclear Rocket Development Station - Nevada (NRDS) which you enclosed with your letter of July 2 to Governor John A. Love was referred to the Colorado Department of Health for review and comment.

The following comments are general and refer only to the small portion that may affect Colorado in the event of a maximum accident. The protective actions described in Paragraph 6.8 are commendable and in most respects similar to the guides used in Colorado at this time. In Paragraph 7.0, the coordination with local and State agencies is vague in certain respects. It should be essential to discuss what each state is able to do according to equipment and personnel available. Although Colorado is prepared to conduct a full-scale program and is continuously monitoring milk, it would be advisable to know whether a standby alert would be called prior to test firing even though it is very unlikely that an accident might happen. If this is not done, the State and local agencies may experience some delay in initiating safety programs, and it would be difficult to determine whether certain people might have received an unsuspected exposure.

A general clarification would be advisable regarding the small amount of radioactivity dispersed to the atmosphere during all routine testing in the event that meteorological conditions do not favor dispersion. The estimated amounts of activity were not mentioned, and it would be well to know what these are.

No mention was made as to whether surface contamination may build up over a long period of testing even though the amount of radioactivity released for each test is small.

No attempt has been made to comment on the environmental impact for the State of Nevada.

Sincerely,

Roy L. Cleere

Roy L. Cleere, M. D., M. P. H.
Executive Director

RLC:dgr

cc: Governor Love
Department of Local Affairs
Attn: Director of Planning
Mr. Robert Bronstein
Mr. P. W. Jacoe

UNITED STATES
ATOMIC ENERGY COMMISSION
WASHINGTON, D.C. 20545

DEC 3 0 1971

Dr. Roy L. Cleere
Executive Director
State of Colorado
Department of Health
4210 East 11th Avenue
Denver, Colorado 80220

Dear Dr. Cleere:

Thank you for your letter of July 28, 1971, commenting on the draft Environmental Statement for Reactor Testing during FY 1972 at the Nuclear Rocket Development Station, Nevada.

You will note that Paragraph 6.6 and 6.7 of the final statement have been rearranged and modified to make it clear that reactor testing is conducted only under formal controls and only when meteorological conditions are such as to provide good atmospheric mixing and dilution. Conservative estimates of radioactive species which may be released to the atmosphere are provided in Paragraph 6.1.

Build-up of surface contamination over long periods of testing is not considered to represent a substantial environmental impact. In fact, results of recent soil sampling on the NRDS show that the Sr-90 and Cs-137 concentration levels range from 10 to 30 mCi/Km^2, about the same as the National average. Conservative calculations considering all previous nuclear rocket testing give still lower results which may indicate that some of the radioactive material may come from weapons rather than nuclear rocket testing.

Paragraph 7.0 has been revised to provide for notification of the States several days in advance of intended tests as well as on those occasions when it appears that the test effluent is likely to cross the borders of a State. As far as nuclear furnace testing during FY 1972 and 1973 is concerned, the following facts may be of assistance in local health protection planning.

a. No more than one hour of testing will be conducted at any one time.

b. Should the effluent trajectory from such a test be toward Colorado, the maximum integrated air concentration of I-131 at the closest point in Colorado would be lower than the limits of AEC Manual Chapter 0524 and 10 CFR 20 by a factor of more than 100,000. Infant thyroid from ingestion would be less than one mrad.

c. For the worst case accident, the integrated air concentration would be lower by a factor of more than 7,000 and infant thyroid doses would be less than 20 mrad from milk ingestion. This is 1,500 times lower than the nominal action point recommended by the Federal Radiation Council.

d. It would take from one to two days for the effluent to travel the 390 miles to the Colorado border and an additional 3 to 5 days for iodine concentration to peak in milk if cows are on fresh pasture, thus allowing ample time for monitoring and evaluation.

I hope you will find the revised statement and the additional information provided herein helpful.

Sincerely,

John A. Erlewine

John A. Erlewine, Assistant General Manager for Operations

Enclosures:
1. Final NRDS Statement
2. Comments on Draft Statement
3. AEC Response to Comments

cc: State of Colorado
Department of Local Affairs
Attn: Director of Planning
Denver, Colorado
w/Enclosures

IDAHO STATE PLANNING
&
COMMUNITY AFFAIRS AGENCY

Date: 9-8-71

To: John A. Erlewine

From: Ezra M. Hawkes, Planner

X for your information

___ for your comments

___ as requested

___ please return

Comments:

September 3, 1971

RECEIVED
SEP 7 1971
STATE PLANNING AGENCY

Mr. Ezra M. Hawkes
State Planning and Community Affairs Agency
Statehouse
Boise, Idaho 83707

Dear Mr. Hawkes:

As discussed with you by phone, we have completed our review of the U.S. Atomic Energy Commission's "Draft Environmental Statement for Reactor Testing During FY-1972 at the Nuclear Rocket Development Station, Nevada. June-1971."

Our comments follow:

> The document provided does not contain sufficient information to adequately evaluate any environmental effect in the State of Idaho as a result of the planned release of radioactivity from a series of 12 nuclear rocket engine tests over a one-year period.
>
> The only biologically significant element planned for release in a sufficient quantity to be a potential environmental problem is radioactive iodine-131.
>
> Although the design of the exhaust gas cleaning system employed in these nuclear rocket tests claims a "scrubbing" efficiency of 98% for radioactive iodine-131, the system can probably still stand to be improved upon. The "scrubbing" of iodine-131 isn't that much of a problem that the removal efficiency could approach 99% or better.

We thank you for the opportunity to review and comment upon this type of an environmental impact statement, and please call upon us again if we can be of further assistance.

Sincerely,

Michael Christie

MICHAEL CHRISTIE, Chief
Radiation Control Section
Environmental Improvement Division

MC:kh

cc: Vaughn Anderson
cc: Environmental Protection Agency
Region

UNITED STATES
ATOMIC ENERGY COMMISSION
WASHINGTON 25, D.C.

DEC 2 [illegible] 1971

Mr. Ezra M. Hawkes
State Planning and Community Affairs Agency
Statehouse
Boise, Idaho 83707

Dear Mr. Hawkes:

Thank you for forwarding the comments of Mr. Michael Christie on the "Draft Environmental Statement for Reactor Testing During FY 1972 at the Nuclear Rocket Development Station, Nevada".

It is difficult to be very precise about the commulative environmental effects from twelve individual tests for two reasons:

(a) The efficiency of the effluent gas cleaning system has not been firmly established, and

(b) The wind direction is not known in advance.

We agree that iodine removal efficiencies higher than that claimed in the statement have been achieved by others and are likely with the Nuclear Furnace. It must be remembered, however, that we are not dealing with air as the carrier gas at low flow rates and near room temperature. Rather, the Nuclear Furnace effluent is hydrogen gas at very high volumetric flow rates and initially at a temperature of about $4000^{o}F$. Much of the effluent gas cleaning system is associated with cooling the hydrogen down to near room temperature. The effectiveness of this part of the equipment as well as the scrubbing and phase separation equipment cannot be stated with full confidence on the basis of calculations and laboratory scale experiments alone. For this reason, the iodine removal efficiency will be measured during the first tests of NF-1. We will be pleased to advise you of these results.

Although prevailing winds during the Summer months are from the southwest to the northeast, it is doubtful that the effluent trajectory would pass into Idaho for as many as six of the twelve tests planned. Assuming they did, however, the maximum infant thyroid dose from both ingestion and inhalation is estimated to be about 4 mR or less at the closest point in Idaho. For the worst case accident, the dose at that distance would be less than 20 mR. If iodine removal efficiencies prove to be higher than claimed in the draft statement, thyroid doses will be proportionally lower.

You will note that additional information related to surface soil concentrations has been added to paragraph 6 of the final statement.

Thank you again for your comments and interest.

Sincerely,

John A. Erlewine

John A. Erlewine
Assistant General Manager
for Operations

Enclosures:
1. Final NRDS Statement
2. Comments on Draft Statement
3. AEC Response to Comments

bcc: OCR (2)
OGC
OEA
AMO
SNS

OFFICE OF THE GOVERNOR
STATE CAPITOL
SALEM 97310

TOM McCALL
GOVERNOR

August 16, 1971

John A. Erlewine
Assistant General Manager
for Operations
United States Atomic Energy Commission
Washington, D. C. 20545

Re: Reactor Testing FY 1972
Nuclear Rocket Development
Station - Nevada
PNRS #71.0320

Dear Mr. Erlewine:

Your draft Environmental Impact Statement for Reactor testing for FY 1972 at the Nuclear Rocket Development Station-Nevada (NRDS), has been received and referred to the appropriate State agencies for review and comment.

Mr. Marshall Parrott, Chief of the Radiation Section of the Oregon State Board of Health reviewed the draft in depth. Mr. Parrott concluded:

"1. This environmental statement is not adequate.
2. The method of operation does not meet established environmental criteria.
3. Either the operation should be brought up to standards or terminated immediately."

His detailed comments are attached hereto, and by this reference we intend them to be a part thereof.

In transmitting this review, Dr. Edward Press, State Health Officer, added the following:

"I have reviewed these (comments) and althouth they are a bit strong, do agree in principle, and specifically that further precautions are needed.

> "I would suggest that these comments be relayed directly to Mr. Newell of NASA, and Mr. Hillingsworth of the AEC, with a statement that they should feel free to contact Mr. Parrott directly for further comment or information."

We concur with Dr. Press and urge that these comments be given your serious consideration.

We are anxious to know what action will be taken on the expressed concerns of the State of Oregon. Please keep us currently advised of any significant activity.

Cordially,

Kessler R. Cannon
Assistant to the Governor
Natural Resources

COMMENTS ON
ENVIRONMENTAL IMPACT STATEMENT FOR
REACTOR TESTING DURING FISCAL YEAR 1972
AT THE NUCLEAR ROCKET DEVELOPMENT STATION, NEVADA
DATED JUNE 1971

This particular Environmental Impact Statement has some typical, yet unfortunate, choices of words such as: "a small percentage of fission products generated during power operations become entrained ..."; "should result in minimum loss of radionuclides"; "Most fission products decay rapidly with time so that concentrations are low by the time the effluent reaches inhabited areas."

A major problem is seen with the report by R. F. Grossman summarizing the whole body gamma exposure and infant thyroid doses resulting from off-site physical measurements made at eight 45° sectors surrounding the test area. There is a question as to whether these eight areas were adequate to form a true measure of the amount of iodine which may have found its way into local milk supplies as, for example, the off-site surveillance for three events at the Nevada test site--January and March 1968, in Radiological Health and Data Reports, Volume 10, Number 3, March 1969.

Inasmuch as these engines are considered power sources, I do not see why they should not meet the same requirements set down by the Atomic Energy Commission for nuclear power reactors producing electricity.

Page 4, Section 2.1: The nuclear furnace is a new type of reactor and is yet untested; therefore, prior information regarding tests of nuclear engines is not valid. The rocket engine spews radioactivity several thousand feet into the air. The diurnal wind patterns from north to south and south to north during any given twenty-four hour period would result in deposition on some of the populated areas, north rather than west, south, southeast or southwest of the area, specifically in the area of Warm Springs, Clark Station, and Tonopah. These are not included in the Environmental Impact Statement.

Using hydrogen as part of the propulsion media is considerably more dangerous here than it would be in space as it can leave itself open to rather high intensity explosions. A statement regarding this potential accident event would be apropos.

Radioactive material storage north of E-MAD will be accumulated in "suitable containers" as at Hanford? It is interesting to note that radioactive material in quantities of approximately 500 curies are buried on-site. Should land use be a problem, it appears that this facility would not be suitable for any type of agricultural use, for example, fruit trees.

The liquid wastes, as described in 5.3.2, are allowed to pass into a drain field approximately six feet below ground level in an area of approximately 3,000 square feet. Approximately 18,000 cubic feet of earth must be removed prior to reaching the radioactive effluent. I do not see where this particular place would be referred to as not being irreversible on a long-term commitment of land.

Section 6.2: Which direction is downwind? North or South? The total thyroid doses at 15 miles appear to exceed the limits allowed for nuclear power reactors producing electricity.

Section 6.3, liquid waste, the statement: The activity is "monitored and the flow automatically terminated if the radioactivity exceeds a pre-set level." If this monitoring is for tritium, the analysis will take longer than the run.

For the question on 6.4, the effects of accidents, what are the new fission products and what are the "insignificant amounts"?

Under Section 7, coordination with local and state and federal agencies, I find the statement "SWRHL will notify officials of neighboring states if it appears that test effluent is likely to cross their borders." Such notification has not been made previously to the State of Oregon following the 1970 release of radioactive materials from the Project Plowshare underground nuclear detonations on the Nevada test site and, unless there is some organized effort of the various states, it will become necessary for action to take place by those states.

I suggest the statement on Page 26, "NRDS is part of a large government controlled complex committed to nuclear rocket development testing." "...that any consideration of alternate sites is not warranted."

1. This environmental statement is not adequate.
2. The method of operation does not meet established environmental criteria.
3. Either the operation should be brought up to standards or terminated immediately.

Marshall W. Parrott
July 30, 1971

UNITED STATES
ATOMIC ENERGY COMMISSION
WASHINGTON, D.C. 20545

DEC 30 1971

Mr. Kessler R. Cannon
Assistant to the Governor
Natural Resources
Office of the Governor
State Capitol
Salem, Oregon 97310

Dear Mr. Cannon:

The comments of the State of Oregon on the Draft Environmental Statement for Reactor Testing During FY 1972 at the Nuclear Rocket Development Station, provided in your letter of August 16, 1971, have been given careful consideration. We cannot agree with the conclusions reached by Mr. Marshall Parrott. To the contrary, we believe that the draft statement adequately describes the environmental effects and that the proposed Nuclear Furnace testing meets all applicable criteria.

Mr. Parrott states that the draft statement contains several qualitative statements. We would point out, however, that these qualitative statements appear in the introductory descriptive portions of the statement and that each of these is quantified in subsequent paragraphs.

We are convinced that monitoring for radioiodine and other radionuclides is thorough in all sectors surrounding the test site and that the results have been reliably reported. This monitoring has been conducted over the years by the same experienced organization, the Southwestern Radiological Health Laboratory (SWRHL), now renamed the Western Environmental Research Laboratory (WERL) of the Environmental Protection Agency. Continuous monitoring of dose rates and air, water and milk concentrations is routinely performed in all sectors and populated locations. In addition to the continuous operation of this network, WERL operates aircraft equipped with very sensitive detection equipment during test operations so as to determine the exact trajectory of the effluent. Ground monitoring teams are then directed by these radio-equipped aircraft to locations in the path of the effluent.

The fact that R. F. Grossman does not report whole body or thyroid dose resulting from nuclear rocket testing in the sector including Tonopah, Warm Springs and Clark Station does not result from inadequate monitoring. Rather, prevailing winds are such that effluent trajectories into that section are very improbable. During the eleven year period of nuclear rocket testing, the main effluent trajectory from nuclear reactor tests has never entered the 315° to 360° sector of interest to Oregon although on two occasions the fringes of the effluents were detected in that sector. Readings by monitors were generally negative. The few positive readings were equivalent to thyroid doses of less than one mrad and were thus not reported by the author in accordance with his stated convention.

With respect to your comment that the Nuclear Rocket Development Station (NRDS) tests should "meet the same requirements set down by the AEC for nuclear power reactors producing electricity," we would point out that NRDS tests have very few similarities to central power stations either in the reactor, the reactor sites or the operating requirements. Notwithstanding the lack of identity between NRDS and nuclear electric generating systems, the same principles of minimizing radiation exposure and environmental impact apply to NRDS testing and each such test is reviewed carefully in context. Specifically, design objective and operating conditions are limited to keep radioactive effluents to a practicable minimum and assure that the acceptability of any anticipated exposure or environmental impact is related to the reasons for permitting such exposure or impact. In addition, performance measurements as well as research and developments of new and improved techniques are constant ongoing efforts to assure that all such effluents are in fact limited to a practical minimum and that technology is developed for further effluent reduction. The anticipated radiation exposure and environmental impact for the nuclear furnace test are appropriately cited in the enclosed environmental statements. We believe that these evaluations reflect sufficient protective conservation and that experience in previous tests at NRDS confirms that actual exposure and environmental impact will constitute at most a few percent of applicable standards.

As stated in Paragraph 6.0 and 6.7.2, nuclear rocket development testing at the NRDS does in fact meet all applicable AEC requirements, specifically AEC Manual Chapter 0524 and the recommendations of the Federal Radiation Council, the National Council on Radiation Protection and the International Commission on Radiological Protection. On the basis of off-site monitoring by WERL, there is no known case of actual exposure above 10 mrem to any individual off-site during any year from nuclear rocket testing.

In addition to the fact that actual and hypothetical doses have always been well within the numerical limits, effective steps have also been taken over the years to keep the dose as low as practicable. These include the delay of testing for favorable meteorological conditions so as to improve atmospheric diffusion and for wind directions to assure that the effluent does not pass over nearby communities. Moreover, supporting equipment such as shields, filters, effluent gas cleaning systems and liquid waste treatment systems have been added to minimize release of radioactive materials to the environment.

It is recognized in Paragraph 6.4 of the Statement that in spite of multiple safeguards and precautionary measures, the possibility of an accident during testing cannot be entirely eliminated. Prior to the operation of any new or modified reactor, extensive analyses are conducted to identify possible failures or errors which could lead to accidents and to devise ways to prevent them or to minimize their effects. The possibility of hydrogen fires or explosions has always been recognized in nuclear rocket testing and effective countermeasures have been developed and utilized. Should hydrogen fires or explosions occur in spite of these safeguards at various points in the facility reactor system, the effect would not involve the release of radioactive material in most cases. It was the recognition that the exhaust gas cleaning system could be defeated by a hydrogen explosion under certain unlikely circumstances, however, that led to the statement in Paragraph 6.4 that "the worst case accident might result in the release to the atmosphere of as much as 50% of the contained radioactivity."

As stated in Paragraph 6.4, insignificant amounts of new fission products could be generated as a result of any conceivable accident. For Nuclear Furnace, the type and amount of new fission products would be the same as that generated during one minute or less of normal operation.

The total inventory of radioactive material buried at the NRDS is currently about 20 curies, not 500 curies. It is doubtful that this material would have to be removed in order to assure safe use of the land for other purposes. Should the removal of the soil containing all liquid and solid radioactive waste later prove desirable, the total volume which would have to be excavated would be about 3000 cubic yards, roughly the amount excavated for the basements of four or five conventional homes. Since this is entirely feasible, burial at the NRDS is considered reversible.

The liquid waste monitoring technique referred to in Paragraph 6.3 involves continuous counting of fission product activity in real time. This monitoring is in addition to laboratory analysis of water samples. In reference to tritium production and its detection, dilution by scrubber water is sufficient to reduce aqueous tritium levels to about 5% guidelines without further dilution.

For underground detonations, the WERL practice is to notify neighboring states should there be a release of radioactive material to the atmosphere and if this material is likely to cross their borders. The state of Oregon was not notified following the 1970 release from underground detonations since the effluent trajectory was in a different direction. For nuclear rocket reactor testing, neighboring states will be notified of intent to test several days in advance and again if it appears that the effluent may pass over that State.

With respect to nuclear rocket testing during FY 1972, the following information may be of assistance in local health protection planning:

a. No more than one hour of testing will be conducted at any one time.

b. Should the effluent trajectory from such a test be carried toward Oregon, the maximum air concentration of I-131 integrated over time of passage at the closest border would be about 1.8×10^{-8} Ci sec/m^3 or the same as an annual exposure to an average air concentration of 6×10^{-16} Ci/m^3. This is more than 100,000 times lower than the limit of 1×10^{-10} Ci/m^3 given in AEC Manual Chapter 0524 and 10 CFR 20. Assuming that dairy cows were feeding on fresh pasture at the time of effluent passage and neglecting any milk processing delays, infant thyroid dose from milk ingestion would be less than one mrad.

c. For the worst case accident, the infant thyroid dose from milk ingestion would be about 20 mrad, 500 times lower than the level at which the Federal Radiation Council suggests that protective actions may be warranted.

d. It would take from one to two days for the effluent to travel the 390 miles to the Oregon border and an additional three to five days for iodine concentration to peak in milk if cows are on fresh pasture thus allowing ample time for monitoring and evaluation.

I hope this reply assists in clearing up possible misunderstandings and helps place the nuclear furnace testing in better perspective.

Sincerely,

John A. Erlewine

John A. Erlewine, Assistant General Manager for Operations

Enclosures:
1. Final NRDS Statement
2. Comments on Draft Statement
3. AEC Response to Comments

ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

OFFICE OF THE
ADMINISTRATOR

NOV 18 1971

EPA-319

Mr. John A. Erlewine, Acting
Assistant General Manager for Operations
U.S. Atomic Energy Commission
Washington, D.C. 20545

Dear Mr. Erlewine:

This is in response to your letter of July 2, 1971, requesting comments on the "Draft Environmental Statement for Reactor Testing During FY 1972 at the Nuclear Rocket Development Station-Nevada (NRDS)." We have studied the statement and our detailed comments are enclosed. We apologize for the delay in responding and recognize that this may preclude consideration of our comments in the planning process for the NRDS FY 72 program. We hope, however, that they will be useful to you in preparing for the FY 73 project.

In general, the draft statement does not clearly define the specific criteria used by the AEC in determining what constitutes "acceptable" discharge levels. In addition, calculations of the integrated man-rem doses to be expected in various directional sectors around the site are not included in the statement. Such calculations would facilitate the evaluation of potential effluent trajectories. Knowledge of both the projected discharge levels and the effluent trajectories would permit a better evaluation of the possible environmental impact of the project.

If you have any questions regarding our comments, please contact Mr. Jack Anderson of this office.

Sincerely,

George Marienthal

George Marienthal
Acting Director
Office of Federal Activities

Enclosure

Introduction

This report summarizes an evaluation by the Environmental Protection Agency of the potential environmental effects of experimental reactor tests proposed for FY 1972 at the Nuclear Rocket Development Station (NRDS) located about 75 air miles northwest of Las Vegas, Nevada. The proposed tests involve two Nuclear Furnace cores, the NF-1 and NF-2. The Nuclear Furnaces are to be tested in short time increments at a nominal power level of 40 MWt. In addition, the total accumulated duration at 40 MWt will not exceed two hours for NF-1 nor 10 hours for NF-2. NF-1 testing is planned in the winter months late in CY 1971 or early CY 1972. Operation of NF-2 will involve tests on several days distributed over a period of two to three months late in FY 1972 and extending perhaps into early FY 1973.

Detailed Comments

Our evaluation is based on the information presented in the draft environmental statement submitted jointly by the Atomic Energy Commission and the National Aeronautics and Space Administration and on the experience of EPA's Western Environmental Research Laboratory which has performed off-site monitoring and evaluation for previous tests at the NRDS.

The statement, in general, adequately describes the impact of most aspects of proposed testing of the nuclear furnace. There are, however, several technical points which should be addressed in the final statement. Assuming that these points can be satisfactorily resolved, the project will probably not result in any unacceptable adverse environmental consequences under normal operating situations.

Radiation Aspects

The test controls and engineering aspects of the nuclear furnace appear sufficient to control the fission products released from the fuel elements so that the dose to the public should be well within appropriate federal radiation standards and guidelines. Maximum utilization of the available liquid and gaseous waste treatment systems should allow the system to satisfy the basic criterion of discharging radioactivity at the lowest practicable levels. However, an adequate discussion of subjects addressed in the following comments should be included in the final statement:

(a) The long-term impact of NRDS testing in the off-site areas, i.e., residual levels of radioactivity.

(b) The discussion of winds at the site refers only to the surface layer and not the predominant transport winds for any effluent. The discussion should include data at the higher levels.

(c) The discussion of liquid radioactive wastes should include an estimate of the liquid volume and total activity (in curies) for each significant nuclide and an indication of gross short-lived or long-lived fission products.

(d) The statement refers to the practice of permitting discharges of gaseous effluent from the E-MAD building and liquid effluent from the nuclear furnace's holdup tank, but it does not stipulate the numerical criteria under which these practices will be carried out or terminated.

(e) The discussion of the downwind dose levels should reflect the significance of potential ingestion doses by other pathways such as drinking water, garden products, etc.

(f) The accident dose level discussion should include the ingestion thyroid dose. It should also estimate the likely effectiveness of the available protective actions and whether this is dependent on the geographical area affected and the time of year.

(g) The estimated doses and the general population distribution should be integrated to indicate the estimated man-rem dose for each sector around the site. The summations for various sectors would be useful information to supplement the dose versus distance information for evaluating potential effluent trajectories.

Solid Waste Disposal

The practice of open burning of solid wastes should be reevaluated. The abundance of space for landfill disposal should rule out open burning, even in this remote non-urban area. If burning is selected, however, it must take place in an approved incinerator which will meet air pollution control requirements. Also, the draft statement should outline the standards that apply. If, as suggested, disposal by land burial is chosen, the procedures to be employed should be fully described in the final statement. To be an approved land disposal operation, the refuse must be compacted in place and covered by at least six inches of compacted soil at the end of each day of refuse placement.

UNITED STATES
ATOMIC ENERGY COMMISSION
WASHINGTON, D.C. 20545

DEC 3 0 1971

Mr. George Marienthal
Acting Director
Office of Federal Activities
Environmental Protection Agency
Washington, D. C. 20460

Dear Mr. Marienthal:

Thank you for your comments of November 18, 1971, on the Draft Environmental Statement for Reactor Testing, FY 1972, at the Nuclear Rocket Development Station, Nevada. They are being included in the final statement.

The specific criteria used by the AEC in determining what constitutes "acceptable" discharge levels of gaseous effluent from the E-MAD building and liquid effluent from the holdup tank are included in Section 2.2 and are based upon the guidelines of the Federal Radiation Council. The numerical criteria are contained in References 3, 4, and 10 of the statement.

Calculations of the integrated man-rem doses to be expected in various directional sectors were not incorporated in the statement because they were regarded to be quite small. Actually the calculations had been made and the results are presented here. Southerly winds (upslope) predominate during the daylight hours when experiments are conducted. Within this 90° wind sector there is a zero population; consequently there is a zero man-rem value. Taking the remainder of the arc (270°) and considering the population census (approximately 4,000 people) out to 50 miles, the integrated calculated man-rem value is less than one per year.

With regard to other technical points raised in the attachment to your letter, the short term residual levels of radioactivity are discussed under Sections 6.0 and 9.0; the predominant transport winds are factored into the downwind dose predictions in Section 6.0 and include consideration of ingestion pathways. An estimate of liquid volume and total activity is not included in the statement because of the changing values in flow to hold-up tanks during test periods and the changes in curie values following test periods due to the relatively rapid decay in radioactivity. We believe that under these circumstances, the treatment and handling of liquid effluents are adequately discussed under Section 5.3.2.

As noted under Section 6.4, thyroid dose from the ingestion route is included in the radiation dose level of 100 mrem. This, of course, would be modified to a considerable extent by taking protective actions which are discussed under Section 6.8.

With respect to your comments on the burning of small quantities of solid non-radioactive waste, reference is made in Section 5.3 to the Federal guidelines which are followed. More specifically, Section 76.8 of 42 CFR Part 76, entitled, "Prevention, Control and Abatement of Air Pollution in Federal Activities" provides for the open burning in non-urban areas of such minimal quantities of waste produced at the NRDS. All such activities at the NRDS are conducted well within this Federal code.

For your information, we enclose copies of the final statement along with comments received and our response to the comments.

Sincerely,

John A. Erlewine

John A. Erlewine, Acting Assistant General
Manager for Operations

Enclosure:
As stated

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